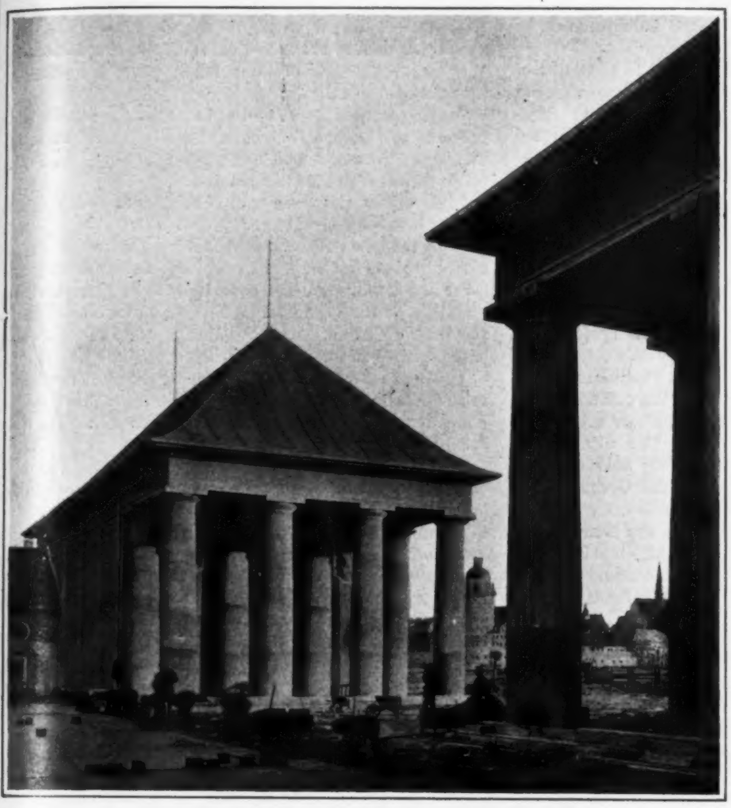
Moneta

SCIENTIFIC AMERICAN SUPPLEMENT

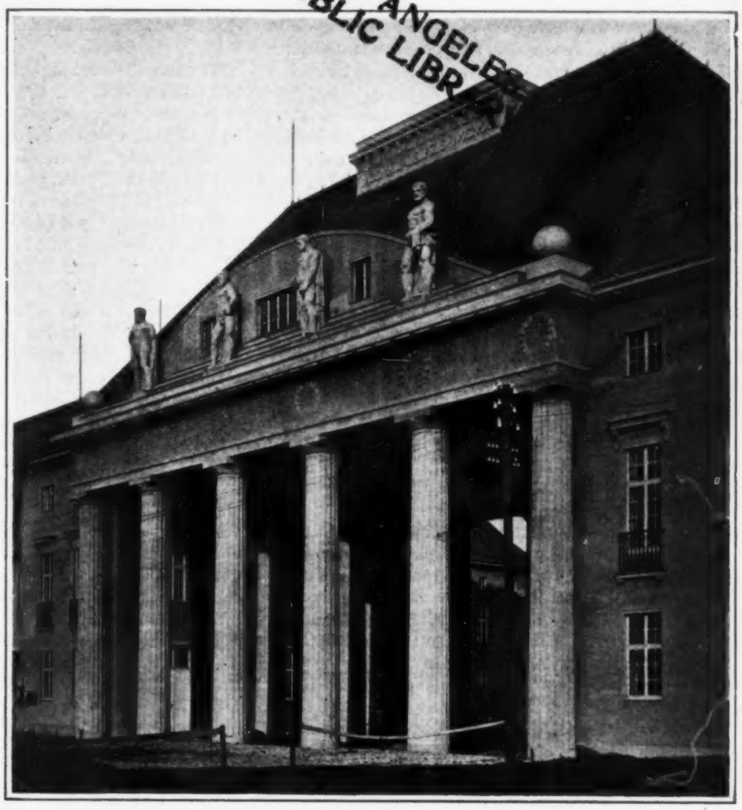
VOLUME LXXVI
NUMBER 1962

NEW YORK, AUGUST 9, 1913

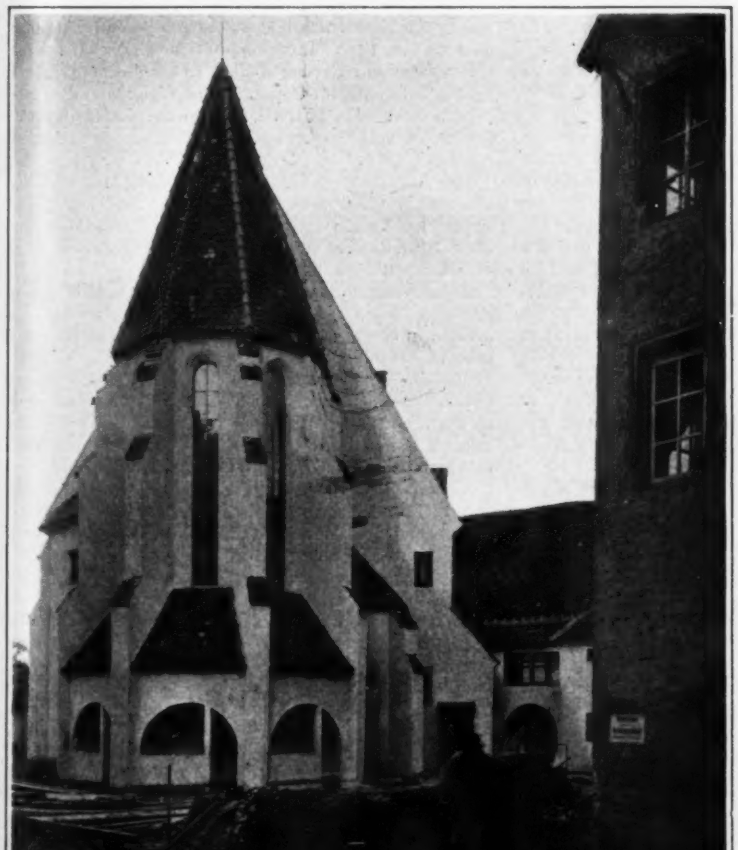
10 CENTS A COPY
$5.00 A YEAR



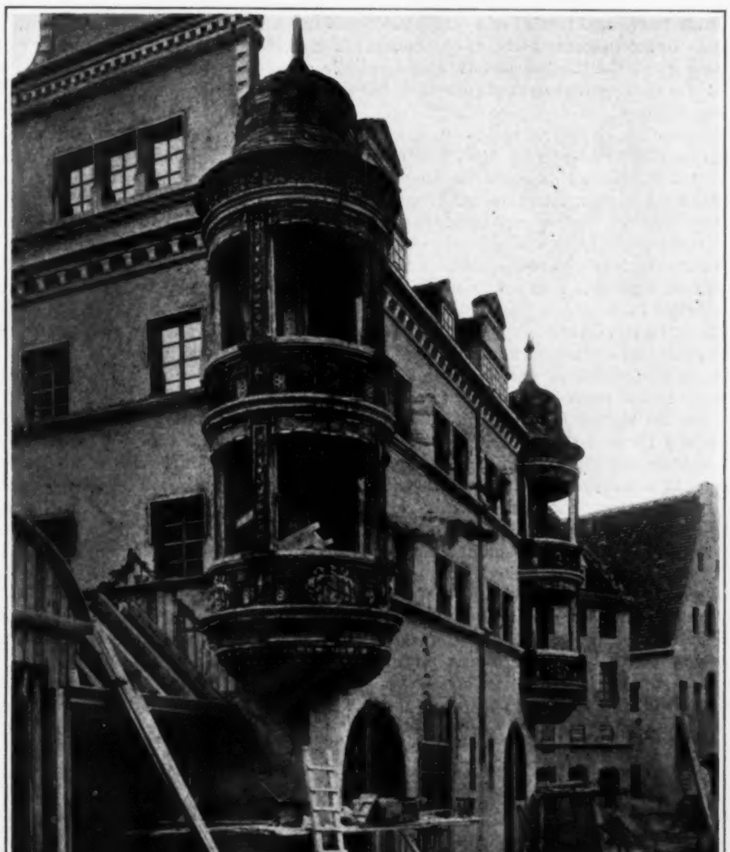
The main entrance to the exposition.



The general administration building.



Leipzig of one hundred years ago. St. Thomas Church.



Exquisitely decorated corner window in the Prince's palace.

THE LEIPZIG BUILDING AND TRADES EXPOSITION.—[See page 88.]

The New International Carat of Two Hundred Milligrammes—I*

A Movement for Uniformity in Jewelers' Weights

By George Frederick Kunz, Ph.D., D.Sc.†

The manifold inconveniences resulting from the absence of a uniform standard of mass for determining the weight of precious stones have long been obvious. This lack has been keenly felt in commercial transactions, and those who have devoted time and research to the study of historic diamonds and precious stones have had frequent occasion to deplore the absence of such a standard in the past.

In a paper read in Chicago in 1893, before the International Congress of Weights and Measures, held in connection with the World's Columbian Exposition, the writer suggested dividing the carat into 100 parts, and constituting a standard international carat of 200 milligrammes; that is, 5 diamond carats or 20 pearl grains to a French gramme, making 5,000 carats or 20,000 pearl grains to a kilogramme. He also called attention to the fact that while this would depreciate the present diamond carat or pearl grain only about 2.5 per cent, it would abolish the troublesome discrepancies between the various carat-weights now in use, and could be easily explained and understood everywhere.[1]

The subject of the various diamond carats, their incongruity, and the resulting confusion as to the correct weights of historic gems when definite records of them are searched for, has been fully treated by me in an extensive study of this subject in "The Book of the Pearl."[2]

To the earnest and unremitting efforts of C. E. Guillaume, Director of the Bureau Internationale des Poids et Mesures at Sèvres, is largely due the eventual success of this eminently desirable reform, which he has constantly urged both by articles on the subject and by addresses delivered in Paris before the International Committee for Weights and Measures.[3]

The general adoption of a uniform standard for dealings in precious stones, based upon a carat of 200 milligrammes, was early recognized to be a result much to be desired, and great progress has recently been made in this direction. The carat has heretofore varied in weight in the different countries, with more or less resulting confusion and inconvenience to business. The metric carat has now been formally adopted in most of the countries of Europe, and its use made compulsory. Our own country has at last taken action and even Great Britain will do so before long. Many of our dealers and importers recognize the theoretical advantage and the convenience of the change, but they apparently fail to take any active interest in it, as a practical reform. There can be little question, however, that the change must come ere long. A single standard for all countries, and the substitution of decimal for common fractions in the carat, are advantages so plain that they must surely soon be realized.

A striking illustration of the defectiveness of the system hitherto in use, as compared with the proposed new standard, is given in a recent article by L. J. Spencer, of the British Museum, on The Larger Diamonds of South Africa.[4] In this article an effort is made to clear up certain published errors and misstatements as to the great diamonds obtained in recent years from the African mines. But it proved impossible to ascertain definitely the precise weights of some of these notable stones, especially those of the earlier discoveries, on account of the uncertainty as to which carat-weight had been employed in determining them. The metric equivalent of the present "Board of Trade carat" is 205.304 milligrammes; while that of the old English carat, in use prior to 1888, was 205.409 milligrammes. Hence, with some of the stones, only an approximate statement of their original weight is now possible.[5]

A first step in the direction of simplifying the carat-weight was taken in 1871, when the syndicate of Paris jewelers, goldsmiths, and others dealing in precious stones proposed the adoption of a carat of 205 milligrammes (3.1636 grains) to take the place of the older French carat of 205.5 milligrammes (3.17135 grains); this action was confirmed in 1877. On October 17th, 1890, the Association of Diamond Cutters of Antwerp fixed the value of the carat at 1 kilogramme=4,875 carats, which gave a carat of 205.183 milligrammes, or 3.16561 grains troy.

The more radical and effective change to the carat of 200 milligrammes was the subject of a resolution passed in January, 1906, by the Chambre Syndicale de la Bijouterie, Joaillerie et Orfèvrerie de Paris, and the Chambre Syndicale des Négociants en Diamants, Perles, Pierres Précieuses et des Lapidaires de Paris, and the reform was strongly advocated by M. Guillaume, in 1906, before the Commission des Instruments et Travaux. Shortly before, in the early part of 1905, the German Federation of Jewelers had petitioned the Imperial government to legalize the carat then in common use as a standard weight, but this was refused as in violation of the law prescribing the exclusive use of the metric system. In the course of the discussion aroused by this refusal, M. Guillaume advocated the new international carat of 200 milligrammes as a possible solution of the difficulty, and as early as April, 1905, this proposition was taken into consideration by the International Committee. In August, 1906, on the motion of Ludwig Schröder, the following resolution was adopted by the German Federation: "Considering that it is both necessary and advantageous to replace the old carat by the metric carat of 200 milligrammes, the Federation authorizes its president to approach the Imperial government and the foreign associations in order that the metric carat may be introduced as soon as possible in all countries."

Following the action of the International Committee, on December 7th, 1906, the Chamber of Commerce of Antwerp promised to rescind the resolution of April 29th, 1895, approving the adoption of a carat of 205.3 milligrammes, as soon as the new international carat of 200 milligrammes should come into universal use in the markets. About the same time the Association of Jewelers and Goldsmiths of Prague formally authorized the German Federation to propose in its name the reform of the old carat as soon as possible by international agreement, and the Association of Goldsmiths of Copenhagen declared its willingness to support such a measure. The Belgian Committee of Weights and Measures, in July, 1907, declared its willingness to petition the government to legalize the new carat on its adoption by the more important countries.

In England and its colonies the proposed change was favorably received. In September, 1907, a resolution indorsing the new carat was passed by the Association of Manufacturing Jewelers of Melbourne, Australia; on October 16th, 1907, the Association of Societies for the Protection of Commerce in the United Kingdom passed a resolution urging its adoption in all countries, and on January 23rd, 1908, the Birmingham Jewelers' and Silversmiths' Association gave expression to the hope that all nations would speedily accept an international carat of 200 milligrammes.

The new carat has now been legalized in a number of countries; in others, laws favoring it are in course of preparation, or of adoption. Definite information has reached us concerning the legal status of the new international carat in the following lands:

Germany.—In the German Empire the question of the carat has been very simply settled, without any new legislation. The fifth article of the law of May 17th, 1856, abrogated the carat in common use, which was not referred to in the laws of August 17th, 1868, and of May 30th, 1908. Now while in most countries not only is the use of non-metric unities prohibited, but also any nomenclature foreign to that of the metric system, the laws of the German empire are silent in regard to this latter particular. Hence those interested can give the name "carat" to the unity they commonly use without coming in conflict with the laws, on the sole condition that this unity be represented by a standard figuring in the table of standards of mass subject to verification.

In conformity with the legal stipulation officially communicated by the Secretary of the Interior to the General Federation of German gem-dealers and jewelers, the Secretary has decided to adopt the new carat.

Belgium.—The draft of a law, signed by the King, was submitted to the Chambers at the beginning of July, 1909. This law has not yet been promulgated.

Bulgaria.—The new carat was included in the provisions of a law published April 10th, 1910.

Denmark.—The first article of a law voted April 1st, 1910, which became operative on that day, is couched in the following terms:

"In the application of the metric system to the commerce in precious stones, pearls, etc., the metric carat, equivalent to 200 milligrammes, shall henceforth be used."

Spain.—A Royal Order of March 11th, 1908, has prescribed the use of the new carat of 200 milligrammes.

France.—The law of June 22nd, 1909, comprises a single article, as follows:

"In the transactions relating to diamonds, pearls, and precious stones, the designation 'metric carat' may, in violation of the first article of the law of July 4th, 1837, be given to the double decigramme.

"The use of the word 'carat' to designate any other weight is hereby prohibited."

Thus the new French law formally prohibits the use of the old carat, but admits that of the new international carat of 200 milligrammes, considered to be an authorized violation of the fundamental law on the application of the metric system. The prohibition regarding the old carat was to become effective from January 1st, 1911, but owing to the difficulty of preparing the proper weights at so short notice, the request of the jewelers that a postponement should be granted until January 1st, 1912, was accorded; since that time the law has been operative.

This law was elaborated in two decrees, of July 7th and of December 13th, 1910. The first of these decrees stipulates that "the form of the carat-weight shall be that of a quadrangular, truncated pyramid, or of a cylinder surmounted by a knob. However, the carat-weights of less than one gramme are to be in the form of square-cut metal plates. The dimensions of the cylindrical weight shall differ from those established for such weights by the fifth appendix to the ordinance of June 16th, 1839.

"The various weights are to be inscribed in intalio and in legible characters, the number of grammes on the lower face; that of the metric carats, followed by the abbreviation C. M., on the upper face."

The same decree enumerates the carat-weights constituting the minimum complete series with which the dealers interested must provide themselves; this series is in conformity with the metric system, between 2 milligrammes and 100 grammes.

Holland.—The law defining and legalizing the carat of 200 milligrammes was laid before the Second Chamber on June 9th, 1910. In the exposition of the motives for its preparation reference is made to the desire expressed by the International Committee of Weights and Measures in its session of 1905, and to the decision of the Fourth General Conference. This law was promulgated April 7th, 1911.

Italy.—Parliament has already legislated, in principle, the new international carat (July 7th, 1910); a Royal Decree will fix the date on which it shall come into use, after consultation with the National Commission of Weights and Measures.

Japan.—An ordinance of November 11th, 1909, specifies that "when the weights of precious stones are expressed in carats, the word 'carat' should designate the mass of 200 milligrammes."

Mexico.—The government, considering that the designation "metric carat" merely constitutes an exception to the fundamental law, does not see any objection to tolerate the authorization of its use; it considers that this permission should be of a temporary character.

Norway.—The law authorizing the new carat bears date of May 27th, 1910; the decree putting it in force was promulgated June 17th of the same year. The text of the law is as follows:

"The name 'metric carat' designates a special metric unity of mass, amounting to 200 milligrammes, exclusively destined for the estimation of the price of diamonds, pearls, and other precious stones, and for their sale or purchase.

"The decimal multiplies and subdivisions of the metric carat shall be authorized in so far as they may be necessary.

"The word 'carat' shall be in the future exclusively reserved for the designation of the mass above defined."

The decree establishes the series (similar to the metric series) of the multiple and subdivided weights of the carat. It also specifies that the carat-weights shall have the form of an equilateral triangle, one side of which shall be turned up.

Portugal.—The "metric carat" (*quilate metrico*) is included in the table annexed to the decree of April 19th, 1911.

Roumania.—A Royal Decree of March 3rd, 1910, prescribes, from January 1st, 1911, the use of the new international carat: the verification of the carat-weight is to be effected in conformity with the general rules com-

* Paper read before the American Institute of Mining Engineers.

† Honorary member of the Chambre Syndicale des Négotiants en Diamants, Perles, Pierres Précieuses, et des Lapidaires, Paris, France; Gem Expert, Tiffany & Company.

[1] See *The Book of the Pearl*, by George Frederick Kunz and Charles H. Stevenson, p. 325 (New York, 1908).

[2] *Ibid*, pp. 321-329.

[3] See C. E. Guillaume, Les récents progrès du système métrique; reprint from vol. xv. of *Travaux et Mémoires du Bureau Internationale des Poids et Mesures*, pp. 62-66 (Paris, 1907).

[4] *Mineralogical Magazine*, vol. xvi., No. 74, pp. 140 to 148 (London, Oct., 1911).

[5] G. F. Kunz, Precious Stones during 1911; reprint from *The Mineral Industry*, vol. xx., pp. 624, 625.

prised in the law concerning weights and measures.

Russia.—The reform of the carat is comprised in the general law in course of revision.

Servia.—The same conditions obtain here as in Russia.

Sweden.—The law establishing the new carat was promulgated June 10th, 1910; the obligation to observe it was fixed for January 1st, 1911.

Switzerland.—The carat of 200 milligrammes is comprised in the law on weights and measures promulgated June 24th, 1909.

As may be seen the new international carat of 200 milligrammes, adopted or in course of adoption in 17 countries, is prescribed by laws having slightly different texts, according to the sense in which the reform is viewed; in general, the prohibition implicitly contained in the law on weights and measures touching the use of any nonmetric unity is expressly affirmed as regards the carat in common use, but the employment of the word "carat" to designate a mass of 2 decigrammes is admitted as a toleration necessitated by the state of things, and justified by the special conditions of the commerce in precious stones.

In those countries in which no legislation has fixed the value of the carat, but where the metric system is in use, the toleration which has been enjoyed by the ill-defined unity by which the weight of precious stones has been computed, should *a fortiori* be applied to a unity strictly determined by its simple relation to the gramme. We may therefore say that the reform is in reality more general than is indicated by the legal status of the carat.[6]

As a preliminary to the presentment of the law legalizing the use of the new carat in Holland, the measure was submitted by the Minister of Agriculture, Industry, and Commerce to the Amsterdamsche Juwelier's Vereinigung and to the Diamond Exchange of Amsterdam; these bodies concurred in advocating the change.

In conformity with a resolution passed by the Fédération Internationale des Bourses du Commerce de Diamants, Perles et Pierres Précieuses of Antwerp, at the convention of 1912, Adolph Adler presented to the Minister of Industry and to Senator Braun petitions for the legalization of the new carat, and received from the last the assurance that he would urge the passage of a law to that effect in the Belgian Chamber of Deputies.

Not long since some fifty jewelers met in the rooms of the National Jewelers' Board of Trade, in New York, to consider the advisability of adopting the new standard. Prior to the meeting, M. D. Rothschild, who was elected Chairman, had sent out 4,000 postal cards to leading jewelers in the United States, requesting their opinion on the subject of the introduction of a new international carat of 200 milligrammes. Only about 360 replies were received, however, there was some consolation in the fact that but nine of these were negative.

Now that the new carat is likely to be soon in universal use, it would be well to consider whether jewelers should not substitute the use of the gramme for that of the pennyweight. The grain is equivalent to about 64.8 milligrammes (more exactly 64.798918), and the pennyweight equals 1.555 grammes, the troy ounce being 31.1 grammes, and the troy pound 373.24 grammes. There can be little doubt that when the great convenience in computation resulting from the adoption of the new international carat of 200 milligrammes shall have been fully realized, the advantage of using the gramme instead of the pennyweight will become clearly apparant, as in this way the troublesome multiplications by 24, 20, and 12 will be done away with. As five of the new international carats make exactly 1 gramme, all calculations regarding the weights of diamonds, pearls, and precious stones will then be in accordance with the metric system.

An important step in the direction of the official recognition of the new carat was the sending of a communication by Secretary Nagel, of the Department Commerce and Labor, to the Secretary of the Treasury, recommending its adoption as the standard weight in computing the value of precious stones imported into the United States. The draft of this letter was prepared by Director S. W. Stratton, of the Bureau of Standards, October 29th, 1912. After drawing attention to the adoption of the new carat by so many European countries, the following excellent reasons are adduced for favorable action in the matter by the Treasury Department:

"The carat is not the most important element in estimating the value of precious stones, particularly of the diamond, but it is nevertheless important that its value be fixed. The change from the carat now used by the Treasury Department to the one proposed would probably be of no significance in so far as the amount of duty on precious stones collected by the Department is concerned, but it would be very important in its effect upon the unification of standards. I therefore have the honor to suggest that the Department adopt and use the international carat of 200 milligrammes and thus set an example which I feel sure will be followed by the jewelry trade in the United States."

Official steps have been taken by our State Department, at the suggestion of the Treasury Department, tending to secure common action by the governments of Great Britain, Holland, and Belgium with our own in the employment of the new international carat of 200 milligrammes to determine the weight of all precious stones exported or imported into these countries, and the favorable action of the Treasury Department realized was foreshadowed by S. W. Stratton, Director of the Bureau of Standards in Washington, D. C., in a letter of January 28th, 1913.

A number of representative dealers in precious stones met in London, on February 7th of this year, under the auspices of the London Wholesale Jewelers and Allied Trades Association, Ltd., to consider the question of the new carat-weight. One of the speakers informed the meeting that the Board of Trade had been approached on the subject, and it appeared that its members thought favorably of the chances of the adoption of the new system in England after a little more propaganda work had been done there. The Board of Trade does not at present exercise any official control over the diamond weights in use, but a legalization of the new carat would result in the proper testing and stamping of the new series of weights.

A strong point made in favor of the adoption of the metric carat in England is that, according to the English Weights and Measures Act of 1878, the old carat is an illegal weight, this act expressly stipulating that gold, silver, and precious stones should only be sold by the ounce troy, or decimal part thereof. Hence it has been held that, strictly speaking, a contract to buy or sell so many carats' weight of diamonds would be an illegal contract and not enforceable. The new metric carat, on the other hand, would be fully covered by the Weights and Measures (Metric System) Act of 1897, and would therefore constitute a perfectly legal unit of mass.[7]

The carat-weight equaled essentially the Roman *siliqua*, 1/1728 of a Roman pound, 2.91 grains troy, or 188.5 milligrammes. It is interesting to note that at the present time this is the weight of the Bologna carat. The name is derived from the Greek *keration*, "little horn," and refers to the shape of the seed pods of *Ceratonia siliqua*, the carob-tree (St. John's Bread), the seeds of this tree having been used to weigh the precious material because their weight is fairly constant. The word carat has come to us through the Arabic *qîrat*, which became in old Portuguese *quirate*, appearing in modern Portuguese and Spanish as *quilate*. A fourteenth century instance of the use of this word, under the form *garat*, to denote a pearl-weight is given in the *Nuremberg Chronicle*.[8]

The relation of the carat to the *siliqua* does not appear to have been constant, for Isidore of Seville, writing in the seventh century A.D., states that in his time a *cerates* equaled one and a half *siliqua*.[9]

The weight of the seeds of *Ceratonia siliqua*, as averaged from 50 specimens, has been given as 197 milligrammes (3.04 grains); the orange-red reniform seeds of *Erythrina corallodendron* had the same weight, while the lenticular seeds of *Adenanthara pavonina* gave a much higher average, namely 274 milligrammes.[10]

The variations in the weight of the old carat are shown by the statement of Jeffries in 1751 that in his time there were *about* 150 carats in the ounce troy.[11] This would have given (if exactly 150) a carat value of 3.2 grains, or 207.357 milligrammes; later, John Mawe (in 1823) reckons 151.25 carats to the ounce, making a carat of 3.174 grains. The present English carat, having a value of 3.1683 grains, was already given by P. Kelly in 1831,[12] although it was not officially accepted by the English Board of Trade until 1888. Even now the English carat does not come within the scope of the Weights and Measures Act of 1878, while there is good reason to believe that the metric carat would have a legal status under the provisions of the Weights and Measures Act of 1897, touching the use of the metric system.

The following table of carat-weights heretofore in use in the various countries will give the general reader some idea of the chaotic conditions with which gem-dealers have been forced to contend:

DIAMOND CARATS.[13]

	Milli-grammes.	Grains, Troy.
Turin	213.5	3.29480
Persia	209.5	2.29307
Venice	207.1	3.19603
Austro-Hungary	206.1	3.18060
France (old)	205.9	3.17752
France (later)	205.5	3.17135
France (modern)	205.0	3.16363
Portugal	205.8	3.17597
Frankfort and Hamburg	205.8	3.17957
Germany	205.5	3.17135
East Indie	205.5	3.17135
England and British India	205.3	3.16826
Belgium (Antwerp)	205.3	3.16826
Russia	205.1	3.16517
Holland	205.1	3.16517
Turkey	200.5	3.09418
Spain	199.9	3.08492
Java and Borneo	196.9	3.03862
Florence	196.5	3.03245
Arabia	194.4	3.00004
Brazil	192 2	2.96610
Egypt	191.7	2.95838
Bologna	188.6	2.91054
International carat of the year 1877	205.0	3.16363
New international carat	200.0	3.08647

We must note in this table the very wide discrepancy between the heaviest carat-weight, that of Turin, equivalent to 3.2948 grains troy (213.5 milligrammes), and the lightest, that of Bologna, representing but 2.91054 grains troy (188.6 milligrammes). Hence the Turin carat is a little more than 13 per cent heavier than that of Bologna, an enormous difference when we have to deal with such costly commodities as precious stones.

The impossibility of carrying on a diamond business systematically with such an appalling variation in the weight of the diamond carat, and with no possible means of an effective check to determine the accuracy of the weights employed, must be clear to all. It is a fact that a great number of jewelers use a set of weights for as many as 20 years, and in the meantime these weights will either wear off, or, if they are handled and lifted with the fingers, as is often the case, they may become heavier.

A government official informed me at Washington that a number of sets of weights used in various establishments were tried, and, to the astonishment of every one concerned, a wide variation was found in them, due to their long use and to the varying standards of different nationalties. If we had a definite standard, a special set could be kept for testing and checking up, once a month, or every three months, the weights in use, discarding those that varied. Thus, there would be much greater accuracy in the books of an establishment if the new international carat of 200 milligrammes were used.

(*To be continued.*)

Welding Repairs to Boilers

The Marine Department of the Board of Trade have issued the following instructions to surveyors, with regard to repairs to boilers by the electric or oxy-acetylene processes:

The repairing of the boilers of passenger steamers by the above processes has been tentatively in operation for a considerable period; and, in view of the experience gained, the surveyors are informed that, provided the work is carried out to their satisfaction by experienced workmen, these processes may be employed, within limits, for repairing cracks in furnaces, combustion-chambers, and end plates of boilers, and in the same parts for reinforcing the landing edges of leaky riveted seams which have become reduced by repeated chipping and calking. Repairs by the above processes to any of the parts of boilers which are wholly in tension under working conditions, such as cylindrical shell plates and stays, are not allowed.

In some old furnaces which have been repaired by the above processes, it has been found that, after a few months' working, cracks have again developed at parts adjacent to those welded; probably owing to the material of the furnace having become fatigued and worn out by long and severe usage. In dealing with old furnaces, therefore, this fact should be taken into consideration.

In any case in which the proposed repairs to the boilers of passenger vessels by either of the above processes are of an uncommon or unusually extensive character, the particulars should be submitted for the Board's consideration and approval.

After repairs by welding have been completed, the parts at or adjacent to the welds should in all cases be hammer-tested; and a hydraulic test of not less than one and a half times the working pressure should, as a rule, be applied to the boiler after the hammer-testing has been effected.—*The English Mechanic and World of Science.*

[6] Comité International des Poids et Mesures; *Procès-Verbaux des Séances*, Paris, 1911; 2d ser., vol. vi., Session of 1911, pp. 202 to 205.

[7] See W. J. Lewis Abbott and Leonard J. Spencer, in *The Watchmaker, Jeweler, Silversmith and Optician*, pp. 1447, 1449, 1451 (December 2nd, 1912).

[8] Grimm's *Deutsches Wörterbuch*, vol. v., p. 73, art. Karat (Leipzig, 1873).

[9] Du Cange, *Glossarium mediæ et infimæ Latinitatis*, vol. ii., p. 286; s. v. Cerates (Parisiis, 1842).

[10] According to Leonard J. Spencer, a higher average weight for the seeds of *Ceratonia siliqua* has been given, namely, 205.2 mg. or 3.1667 grains, almost exactly that of the English carat; see G. F. Herbert Smith, *Gem Stones*, p. 84 (London, 1912). The average of 3.04 grains approaches very closely to the Florentine carat, 3.03245 grains; this was probably the carat-weight used by Travernier.

[11] David Jeffries, *A Treatise on Diamonds and Pearls*, pp. 2, 3 (London, 1751).

[12] Patrick Kelly, *Universal Cambist* (London, 1881), vol. i., p. 220, where he writes: "The ounce troy weighs 151½ Diamond carats, the carat is therefore 3 1/6 grains troy or 205¼ French Milligrammes."

[13] *The Book of the Pearl*, by George F. Kunz and Charles H. Stevenson, p. 323 (New York, 1908).

The Manufacture of Balls for Bearings

Each Ball is Made True to Within One Ten-thousandth of an Inch

By Thomas J. Heller

UNTIL a year or two ago it was very generally recognized among users of ball bearings that steel balls made abroad were superior to those made in America.

To-day, however, conditions are changed, and America is giving to the world a product that is not only the equal, but in some respects is superior to foreign-made balls.

A manufacturing company of Philadelphia has purchased and has sole control of all the United States patents of Ernest Gustav Hoffman, relating to the manufacture of steel balls. This system comprises the best European method of ball-making, and to this they have added their several years of study, experimenting and research in the ball-making industry, until to-day the process is acknowledged to be the most highly perfected process known, enabling the manufacturer to guarantee that the balls produced are absolutely round and true to size within 1/10,000 inch.

Fig. 1 shows the most delicate instrument known for the measuring of spheres. Its whole range of measurement is only 2/1,000 inch, yet one ball after another can be run through this instrument and the indicating needle will hardly show a flicker.

The steel used in making these balls is a high-grade chrome alloy product imported from abroad, and made in a steel works which employs the Girod electric furnace. Steel made in this furnace is conceded to be the best for this purpose, as it possesses in the highest degree such qualities as resistance to shock, hardness, tenacity and durability after hardening.

This product was adopted after a long series

Fig. 2.—Rough balls after the first grinding and before heat treatment.

of tests and experiments both in the laboratory and in actual practice including chemical analysis of the steel, scleroscope tests for hardness, and photo-micrographs, made on Le Chatelier microscope to determine the structures of the steel both before and after treatments of various kinds.

The first step in making the balls is to heat the steel in specially constructed furnaces, particular care being taken to prevent the steel from being burnt while receiving the forging heat. No direct flame can strike the steel, and the bars are heated slowly and evenly, the temperature being controlled at all times by pyrometers.

When the steel bars have reached the proper temperature they are thrust under a power hammer on which the blows have been carefully adjusted to give the ball a dense homogeneous grain with the molecules holding together with a high cohesive force. This results in a much greater strength in the forged ball than the rolled bar of steel from which it was made, and it has been fully demonstrated that this hot forged method of ball making is superior to any other process. This is particularly true of the larger size balls.

Fig. 3 shows what a string of forged balls look like. After the hammer operation, they next go to a press, where they are cut apart.

The balls are next thoroughly inspected to detect any defects in forging, and are then carefully annealed to remove any internal strains that may have been set up, by the forging. This produces

Fig. 1.—Precision gage for measuring balls.

a state of rest or repose in the steel, and they become uniformly soft and mild and all alike, thus insuring a uniformity of product which is essential to success in the finished ball.

They are next stored and allowed to age for a reasonable time, and are then sent to the rough

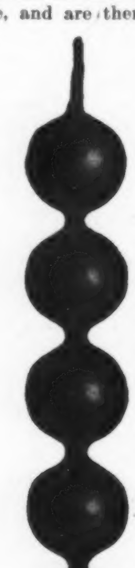


Fig. 3.—A string of forged balls ready to go to the press to be cut apart.

grinders, where the shell or skin caused by forging is removed. In addition, quite an amount of material is ground off to insure the removal of flaws, pin spots, or imperfections which may have been forged into the surface. The ball at this stage is approximately round and clean, although rough, as shown in Fig. 2.

Fig. 5.—Using a ball as a gage to measure sheave.

They are next transferred to a smooth grinder, where they are further perfected as shown in Fig. 4. The ball is now quite round, and only a few thousandths above the proper size.

The balls are now put through a heat treatment process in which pyrometers and thermometers control the temperature at all stages, and when the balls finally emerge from the quenching tanks each and every ball has been subjected to the same degree of temperature for exactly the same length of time. The standard of tests at this period is very rigid and strictly adhered to.

The object of this heat treatment is to so toughen the steel and to refine the grain, that when the final hardening and tempering is done the result will be as perfect a product as it is possible to make.

These balls are hardened clear through, not case hardened on the surface.

The balls now come in for their final grinding operation. The former grinding operations have left the balls about 0.003 inch oversize, which is removed in the final finishing or polishing.

The usual practice of finishing grinding balls is to put a ring full between two revolving cast iron grooved rings, and to lap them with thick black grinding oil and emery grit. This method results in a great variety of sizes being produced, and besides the balls are not round and are covered with scratches, which cannot be altogether removed.

The process of finished grinding is done between extremely hard grinding wheels of special composi-

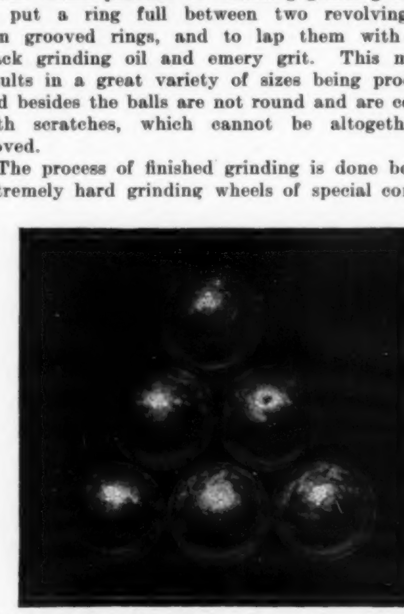


Fig. 4.—Balls polished smooth, but before final heat treatment and grinding.

tion, and when the operation is completed they are all round and true to exact size and all alike and when examined under a microscope the surface is perfect.

At this point the balls are again measured on the instrument shown in Fig. 1 to determine their exact size.

The next step is to burnish the balls by rotating them for a period of approximately three days in specially constructed machines, in which every ball gets the same amount of rotation as every other ball. In order to bring out the balls all alike only balls of one size are put in each machine and when the operation is completed the balls present a mirror-like surface.

The balls are now transferred to the inspection room, where they are examined individually by girls to detect the slightest flaw. Then, in case there should be a chance of oversight, the balls are subjected to a bouncing test, which consists of putting them through a machine which directs the ball toward a steel anvil on the floor, from which the ball bounces into a particular bin. All the balls failing to make the required distance are discarded from the O. K. batch, although they may look perfect on the surface. The finished product is all alike, round and true to size within 1/10,000 inch, and does not vary from ball to ball or from box to box.

A new use was recently discovered for these balls and has recently been placed on the market. It is known as a ball gage, and consists of a han-

dle electrically welded to a ball, and is used for the measurement of internal diameters.

From the time this company started to manufacture balls they adopted the Johannsen's Swedish gage blocks to calibrate the instrument shown in Fig. 1. It will be noted that there are two points between which the ball is measured, and it was found after a time that the constant use of putting balls through the machine would wear a slight hollow on these points, which resulted in a slight error in reading the size of the ball tested. So, after the instrument was once calibrated by the Swedish gage blocks all subsequent calibrations were made by a master ball, because being of the same shape and contour as the standard ball this slight wear on the points of the machine was compensated for, and thus more accurate rapid practical results could be obtained.

While perfecting these minute measuring devices, Mr. Otto W. Schaum conceived the idea of attaching a handle to the ball for a two-fold reason.

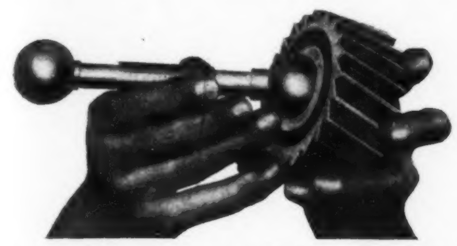
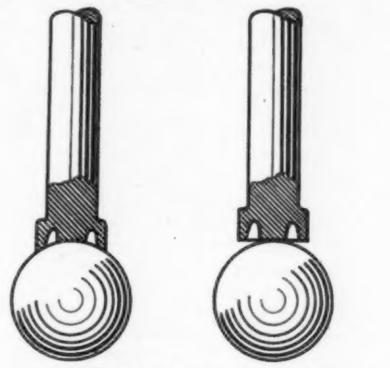


Fig. 8.—Ball gage in use as limit gage. See also the illustration opposite.

First, it would facilitate the handling of the master ball, and second, if the operator got careless and held the ball in the hand too long, the heat was liable to temporarily expand the measurement. The idea then suggested itself that with a handle attached to the ball its use as a measuring instrument could be vastly increased.

It could be used to set a micrometer by, thus preventing a chance of misreading by different workmen. It could be used as a radius gage for rolling mill rolls, for rolling round stock, or as shown in Fig. 5, measuring the radius of a sheave wheel. Also for measuring internal diameters on ball bearings, circular saws, form cutters, disks, gear wheels, flywheels, pulleys, hollow mills, collars, bushings, and machine parts, etc. In fact, it could be readily used as a substitute for the cylindrical plug gages used heretofore, but which have not been generally adopted by mechanics as part of their tool kit on account of their high cost.

As the balls are made in lots of many thousands, these gages could obviously be sold at a very low price as compared with plug gages which must be made one at a time.



Figs. 6 and 7.—Method of mounting ball gage.

Now it would seem an easy matter to attach a handle to a ball, but when the size of that ball must be retained absolutely, and is to be sold under a guarantee that it is accurate within 1/10,000 inch, it is no easy matter.

Remember, the problem was to retain the shape and size of the ball, and any operation such as drilling and tapping a hole in the ball and threading a stud on the handle, trepanning (or cylinder sawing), soldering, brazing, etc., would of necessity have to be done while the ball was in its soft state, hardening, tempering and polishing of the ball would have to be done afterward, and this was an impossibility after the handle was fastened to it, and still retain its accuracy. Besides, the amount of labor would have made it prohibitive in price, even if it could have been accomplished successfully.

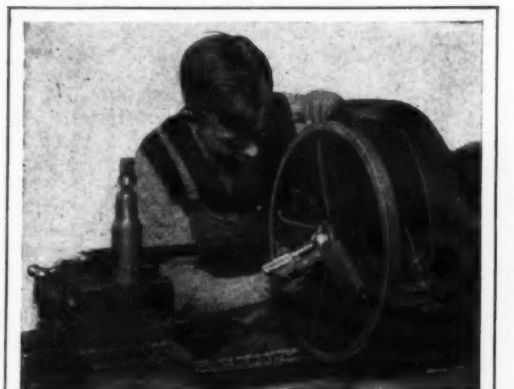


Fig. 10.—The ball gage may be applied at any angle.

Practically everything was tried that looked at all feasible, however, and electric welding was adopted after a series of water cooled dies had been devised to prevent the temperature of the ball from being drawn during the operation of attaching the handle to the ball. The sectional drawing (Fig. 6) shows the ferrule as an integral part of the handle. It will be noticed that the central tongue extends slightly beyond the ferrule.

Fig. 7 shows it attached to the ball, the tongue having been melted until the ferrule also meets the ball and is firmly attached thereto.

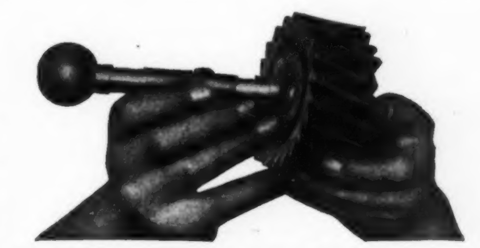


Fig. 9.—One end of the gage has a diameter of 1.251 inches, the other 1.249 inches.

Figs. 8 and 9 show the gage being used as a limit gage, the ball on one end being gaged to 1.251 inches, and the other 1.249 inches. To facilitate the work in handling a gage of this kind, it will be noted that the ferrule on the minus end is smaller than the gage on the plus end, so that a workman can tell by the feel which end he is using, without having to look at the figures on the handle.

A number of advantages of the ball gage over the old style plug gage for measuring internal diameters will readily suggest itself to the mechanical mind, but one worthy of especial mention is the fact that the ball gage presents a series of measuring surfaces, as it is not necessary to put the ball straight into the hole, but it may be applied at any angle, as shown by the operator using the ball in Fig. 10, therefore cannot jam or corner in the hole.

The Waterproofing of Textile Fabrics*

By the Use of Aluminium Salts and of Bichromate-gelatine

By J. Blair

Waterproof fabrics may be divided into two distinct classes. The first class comprises various textures and cloths which have been treated chemically to render them water-repellent, thus preventing the passage of moisture except under pressure. In this class the surface tension of the liquid endeavoring to pass through the fabric plays an important part. The second class consists of fabrics which have been plastered or entirely covered with some waterproofing substance, and are impenetrable to both air and moisture. Oilskin and macintosh are examples of this class. It is intended in this paper to describe only the processes for the production of the first class of goods, requiring in the majority of cases no more complicated machinery than the ordinary padding machine.

The first thing to be considered is that a closely constructed material is more likely to resist percolation by liquid than a loosely constructed article, hence the closer the weave structure the better will the article be to waterproof. The loose cloth from the loom should be given as close a texture as possible by hard to medium milling. Flocks such as the fiber from fulling or shearing may be advantageously incorporated with the cloth during felting, and if union goods are to be proofed, the cloth should be milled until the woolen weft locks up and obliterates the cotton warp. A fabric composed of a worsted warp and woolen weft is excellent for waterproof coatings, but solid worsteds may be proofed equally well when the occasion arises.

In physical structure each wool fiber is a capillary tube, and it is owing to the capillary attraction of these tubes that the affinity of wool for moisture is explained. If a wool fiber is placed under the microscope and a drop of water brought into contact with it, it will be seen to be sucked up with avidity. To render the fiber waterproof these capillary tubes must be filled with a substance insoluble in water. Subjecting the fiber to the action of superheated steam seems also to close up these tubes and the fiber made repellent to water. If in addition the threads are surrounded with a water-repellent substance, it is possible to waterproof even loosely woven fabrics. If water is placed on fabrics thus treated it stands off the fabric in spherical beads, which may be blown or shaken off without leaving any trace of moisture. Of course, if the fabric is submitted to the action of a column of water the pressure forces the water through the interstices of the warp and weft in the form of spherical globules, but the fiber is not "wetted" at all.

WATERPROOFING WITH ALUMINIUM ACETATE.

This is perhaps the most common process, and is in general use for waterproofing covert coatings. The old method was to mix solutions of alum and sugar of lead (lead acetate) and to apply the solution to the piece by steeping or padding. The pieces after scouring and washing were hydro-extracted, and without drying, the solutions were applied. The alum or double sulphate of potassium and aluminium was then replaced by aluminium sulphate, and this is in common use at the present time. A safer plan is to use a solution of aluminium acetate made by the double decomposition of aluminium sulphate and calcium acetate as follows:

$$Al_2(SO_4)_3+3Ca(CH_3COO)_2=2Al(CH_3COO)_3+3CaSO_4$$

One hundred pounds calcium acetate and 700 pounds sulphate of alumina are separately dissolved in water and brought together in a mixing vessel. The precipitate of calcium sulphate is allowed to settle, and the solution filtered through cloths or a filter press. As gray a shade of calcium acetate as possible should be chosen, as the brown or black forms produce a tarry or discolored acetate which is unsuitable for proofing light colored goods.

There are three methods of application of aluminium acetate:

1. Treatment with aluminium acetate in the padding machine for 20 minutes to half-an-hour, followed by tentering or drying by passing over hot cylinders. The acetic acid is evaporated off and the aluminium left on the fabric in the form of an insoluble basic acetate which is repellent to moisture.

2. The second method of application is to pad for 20 minutes in aluminium acetate of from 3 to 5 deg. Bé. and then to after-treat another 20 minutes with a solution of radium carbonate, potassium carbonate, or ammonia. This precipitates the aluminium on the fabric in the form of the hydroxide which dries to the oxide on tentering.

These two methods produce a moderately water-

* Reproduced from the *Journal* of the Leeds University Textile Students' Association.

proof article, and on account of the cheapness are generally used for low goods and unions. After wearing some time the alumina tends to appear in the surface of the cloth in the form of a white powder which may be brushed off and the waterproof value is gradually lost.

3. The third method which tends to remedy these faults is to impregnate with the acetate as before and then after-treat with soap solution. The aluminium is thus precipitated in the form of an insoluble aluminium soap which tends to cling better to the fiber and is more water-repellent than either the basic acetate or oxide. If excess of soap solution is used a "sticky" feel is imparted to the fabric. This may be remedied by passing the material through alum solution of 1 deg. to 1½ deg. Bé.

THE USE OF FATS AND WAXES IN CONJUNCTION WITH THE ALUMINIUM STEARATE PROCESS.

Soap solution possesses the property of emulsifying India-rubber solution, boiled oil, water glass, dextrin, and other gums, and the various waxes such as paraffin, carnauba, Japan, and beeswax. These bodies are invaluable in making the cloth water-repellent and when used as adjuncts to the soap bath, they are thrown down where the alumina-impregnated fabric is passed through the solution. They adhere very tenaciously to the cloth and greatly enhance its waterproof value. Fabrics treated in this way will stand a pressure of about 12 inches, while with a simple soap bath the maximum pressure is about 2 inches.

The following is a typical example of a soap bath made up with Japan or carnauba wax and a 10 per cent solution of Para rubber in oil of camphor or turpentine. The following quantities are required per pint of liquid: Soap, 1 ounce; wax, ⅞ ounce; rubber solution, 20 grains. The wax is melted and the rubber solution mixed in, and the mixture added to the boiling soap solution.

Chloro-hydrocarbon solutions of sulphonated oils are excellent for incorporating rubber and waxes into soap solution, though rather expensive.

WATERPROOFING WITH GELATINE, ETC.

A satisfactory waterproof cloth is obtained by padding with gelatine solution and treating with a second solution to render the gelatine insoluble. Substances possessing this property are formaldehyde, acetaldehyde, tannin and bichromate of potash. If aldehydes are used the gelatine may be replaced by any of the vegetable and marine gums, the majority of which form insoluble aldehyde compounds. Bichromate of potash and tannin should only be used with dark colored heavy goods, as they produce a dark brown color, and also cause light weights to stiffen. A stiff feel is generally characteristic of gelatine proofed goods, and it has to be remedied by suitable finishing. Acetaldehyde is preferable to formaldehyde in being less volatile and easier to manipulate, and also being less irritating to the noses and throats of the workpeople. Thick sacking and wagon cloths are proofed by repeated treatment with gelatine and tannin until the interstices have been filled up and the texture almost hidden. Alum solution, following up treatment with gelatine, will fix the gelatine and give a moderately waterproof cloth. In another process the fabrics are thoroughly soaked in a mixture of isinglass, alum and white soap. They are then passed through a solution of sugar of lead and dried. Glycerine is sometimes added to the gelatine solution to prevent a "stiff" feel.

WATERPROOFING WITH FATS AND WAXES.

Fats and waxes may be applied to cloth dry or dissolved in benzine. The chief varieties used are paraffin, ceresine, Japan, carnauba and beeswax. The dry method of application is to sprinkle the finely powdered wax evenly over the surface of the cloth and then pass the material over heated rollers. The cloth should of course be previously dried, or the wax is not properly melted into it. This method lends itself very conveniently to the waterproofing of made-up garments and coatings, ordinary irons being substituted for the heated rollers.

For the application of benzine solutions of the waxes special apparatus must be chosen to provide for the recovery of the benzine, both on the ground of economy, as the recovered benzine may be used to dissolve more wax, and on account of the vapors being highly inflammable and dangerous. The apparatus should be inclosed and means provided for the condensing of the vapors.

The cloth is dried and passed over a roller into a compartment containing the wax solution, where it is impregnated with the solution. It then enters another chamber and emerging at the opposite side passes over a roller and afterward wrapped round a piece roller. The chamber is heated by means of steam, and as the cloth passes over the hot plate the benzine is distilled off and passes back again to the first chamber, where the vapors are condensed. The apparatus may be varied in many ways, for example, by blowing hot air instead of using the hot plate. A final drying in the atmosphere is necessary in all cases. This is best effected in open sheds with free access of air.

Another process for applying waxes without the use of solvents is as follows: A metallic roller rotates in contact with the solid wax so that it carries away portions of it, and puts them on the fabric so that they are soaked up by the latter as fast as they are fused. The fabric passes between the metallic roller and a heated trough. This method of waterproofing is inferior to the solution method in that the waterproofing substance lies more externally and does not penetrate into the cells.

THE TESTING OF WATERPROOF FABRICS.

In passing pieces for being waterproof the common method of testing is to pour a quantity of water on to a pouch in the cloth. The cloth should be able to stand rubbing underneath and should show no trace of wetness when the water is moved about over the surface of the cloth. This test is valueless when it is desired to make a comparison between different processes or when new processes are being tried on an experimental scale, say, with pieces of cloth 6 inches by 6 inches. A common method is to make a pouch with a piece of cloth by stretching it on a suitable frame.

The underside of the cloth should show no appearance of dampness after two or three days. Another good method is to take about 6 inches by 6 inches and fold it twice like a filter and place in a suitable glass funnel. A definite volume of water is measured into it, and at the end of 24 hours nothing more than a few equally distributed drops of water should be perceptible on the underside. A good cloth will not show any drops on the underside for days.

Many firms make use of the dropping tap for testing their waterproof goods. A bottle or cistern is fitted with a dropping tap to allow drops of water to fall at regular intervals. A wooden frame is inclined at an angle of 45 degrees. One edge of the cloth to be tested is fastened to the uppermost edge of the frame, and the cloth allowed to fall over, the bottom edge being kept taut by means of a bar to which the bottom edge of the cloth is fastened. The drops of water are allowed to drop on the center of the cloth. At first they run down the incline, but after some time elapses, say from 1 to 5 hours, according to the quality of the waterproof, the drops begin to go through the cloth. The time elapsing before this occurs is taken as the value of the proofing. According to the height the water has to fall, minute drops will spray through the interstices, but water does not collect to form a drop for a considerable time.

The dropping test may also be carried out as follows: The cloth is extended beneath the dropping tap, and a piece of blotting paper placed underneath the portion of cloth where the drops will fall. Sixty drops are allowed to descend from an elevation of six feet, and if the blotting paper shows no wetness after the test the cloth is considered satisfactorily proofed.

The thistle funnel forms a convenient and excellent means for the comparative testing of waterproof fabrics. A portion of the cloth is tied firmly onto the thistle end, and the funnel fixed in an inverted position in a clamp. By means of a wash bottle the globe part is filled with water. This will represent about one inch pressure, and any cloth if at all waterproof will stand this. With a pipette the pressure of water is gradually increased, the water level mounting up the stem of the funnel. One should be able to increase the pressure until it is sufficient to force drops between the interstices. The level in the stem of the funnel now falls some distance when it remains constant and will stay for days.

The height of the water is measured and may be taken as indicating the degree of "proofing." Anything above two inches of water is quite good. The underside should not become wet and the water when forced through by the pressure should be in evenly dispersed drops. It is also possible to get figures by filling up to a certain height for each test, and measuring the time elapsing before the first drop appears on the underside or the amount of water passing through in a certain time, say 10 hours. More elaborate modern testing apparatus is very similar to the foregoing in principle. A column of water is allowed to act on the test sample and the water passing through in a given time is measured.

In one such apparatus a graduated burette has its lower extremity closed with an attachment resembling a polarizing tube, but instead of a glass disk as in such tubes the sample of cloth is cut to correct size and fitted in. A slanting outlet is cut through the metal attachment and a small measuring flask placed underneath. The burette is filled up to the zero mark, and the amount of water falling through in 24 hours collected.

The Optical Activity of Petroleum and Its Significance*

New Light on the Nature and Origin of Mineral Oil

By F. W. Bushong

The wide distribution of deposits of bitumen, in its various forms, is attested in the very earliest writings, both sacred and profane. In the book of Genesis we learn that slime was used for mortar, and in the second book of the Maccabees we are told that

"Neemias commanded the priests to sprinkle the sacrifices with the thick water . . . and when this was done . . . there was a great fire kindled, so that every man marveled."

Herodotus gives us the following description of the manner of its collection:

"At Ardericca is a well which produces three different substances, for asphalt, salt and oil are drawn up from it in the following manner: It is pumped up by means of a swipe, and, instead of a bucket, half a wine skin is attached to it. Having dipped down with this, a man draws it up, and then pours the contents into a reservoir, and, being poured from this into another, it assumes these different forms: the asphalt and the salt immediately become solid, but the oil they collect, and the Persians call it rhadinance. It is black and emits a strong odor."[1]

For more than 2,500 years the disciples of Zoroaster have worshiped the "eternal fires" in the neighborhood of Baku, Russia, and not until recently have their temples been replaced by oil reservoirs and refineries.

Within the last half century a new shrine has been set up in oildom, and our modern devotees have shown such zeal and activity that it may again well be said "that every man marveled." But the marvelous development of the petroleum industry has been rendered possible only by reason of the gigantic strides which have been made in the fields of natural science and technology. We may look for even greater things in the future, for science is still in its infancy.

In the year 1835 Jean Baptiste Biot published his memoir on the circular polarization of light and its application to organic chemistry,[2] which contains a table giving polarimetric data regarding essential oils. This includes a sample of "naphte" rectified by distillation, which, examined by red light gave a rotation to the left equivalent to 15.21 degrees for a tube length of 200 millimeters. It is, however, very unfortunate that we have no information as to the source of this very remarkable sample.

Nearly fifty years later, in connection with their researches upon the petroleum of the Caucasus, Markownikow and Ogloblin examined the natural

* Address of the retiring president of the Kansas Academy of Science. Read December 23rd, 1912, at Topeka, Kan., and published in *Science*.

[1] "Petroleum and its Products," S. F. Peckham, 1882, p. 1.

[2] *Mem. de l'Acad. de Sciences*, 13: 39, 1835. See also "Die Polarimetrie der Erdöle," M. A. Rakusin, Berlin, Wien, p. 6, 1910.

"white naphtha" as well as some petroleum distillates, and, finding these samples inactive, they did not continue this subject any further. In 1885, however, Demski and Morawski examined some of the more important mineral oils of commerce, among which one rotated the plane of polarization 1.2 degrees to the right. In 1898, Soltsien found that the commercial paraffin oils are dextrorotatory, and that the amount of rotation increases with their specific gravity. Since that time general interest has been awakened in this subject and petroleums from all parts of the world have been examined polarimetrically. In general, it has been found that the lightest and least colored oils (including the so-called white naphthas) manifest little or no optical activity, while the heavier, dark and viscous oils yield active products.

In a typical Kansas oil, examined in connection with the work of the University Geological Survey, slight optical activity was detected in the upper kerosene fraction which distilled between 250 and 300 degrees under ordinary atmospheric pressure. The higher boiling portions of this oil after fractional distillation under diminished pressure were dextrorotatory, the amount of rotation gradually increasing with the rise in boiling point until, in the neighborhood of 280 degrees at 27 millimeters, it reached almost one degree of arc.

In some oils a maximum activity has been observed in the vacuum distillates collected at about 275 degrees, and in the case of a German oil a second maximum was reached at a temperature of 310 degrees. Javanese petroleum yields vacuum fractions boiling about 150 to 180 degrees which are lævorotatory, but the higher boiling fractions are dextrorotatory. A sample of petroleum from Borneo yielded a distillate collected between 260 and 340 degrees under atmospheric pressure which was lævorotatory.

But the fractions obtained in the distillation of petroleum do not represent distinct chemical individuals, but consist of more or less complex mixtures. Hence it is necessary for us to make use of other processes before we can isolate the optically active constituents. The fact that the distillation products of petroleum have found such a ready market without the necessity of chemically transforming them has, no doubt, greatly hindered the development of chemical methods for their utilization. But in recent years competition in the refining of illuminating oils is beginning to force the refiners to look to the utilization of their waste products. In Russian refineries the alkaline sludges are now treated so as to recover the so-called naphthenic acids which find a ready market for the manufacture of soaps.

The fact that the naphthenic acids derived from kerosene show greater optical rotation than the kerosene was first observed by Rakusin. The naphthenic acids derived from lubricating oils were found by Marcusson to be much more strongly active than those derived from kerosene.

A study of isomeric naphthenic acids has recently been made in the laboratory of industrial research of the University of Kansas. Commercial napthenic acids, after being freed from hydrocarbons, were converted into esters, which were repeatedly fractionally distilled. The lowest boiling fractions were strongly lævorotatory. The succeeding fractions showed a gradual decrease until in the intermediate fractions a neutral or inactive point was reached. Above this there was a gradual increase in dextrorotatory activity. A portion of free naphthenic acids, which were similarly purified, were separately fractionated and gave results exactly parallel to those of their esters, the only difference being that the boiling points of the free acids were uniformly about 50 degrees higher than the boiling points of their methyl esters. In other words each and every optically active constituent boiled 50 degrees higher in the one case than in the other. This shows that these optically active constituents are acids which are esterifiable, and marks the first distinct step toward their isolation. The simplest interpretation of these facts is that the cause of the optical activity resides within the naphthenic acids themselves.

It does not necessarily follow, however, that the optically active constituents present in the commercial naphthenic acids are identical with those originally present in the petroleum. There seems to be good evidence that this is not the case, for it has been shown by Albrecht that the optical activity of lubricating oils is not appreciably reduced by thorough refining by means of alkali. This result has also been confirmed by experiments with the Kansas oil distillates already mentioned, which retained most of their optical activity after being boiled with alcoholic potash. On the other hand, these experiments do not prove that no optically active acids are removed by the treatment with alkali, for it is quite possible that both lævorotatory and dextrorotatory acids may be removed in approximately equal quantities. To satisfactorily settle this question an experiment should be carried out at a refinery upon a large quantity of oil.

The naphthenic acids are generally believed to be the oxidation products of the naphthenes, or saturated cyclic hydrocarbons of the series C_nH_{2n}, which are present in most of the petroleums, but particularly in those of Russia. It is to be expected, therefore, that active acids should result from the oxidation of certain active hydrocarbons. The determination of the constitution of any of the active acids to be found in petroleum products would thus shed light upon the constitution of the active parent hydrocarbons.

The crucial test as to the correctness of our knowledge of the constitution and structure of organic compounds depends upon the methods for their synthesis. But chemical synthesis is a species of architecture, and just as the architect before beginning the erection of his structure must lay down his plans and draw his designs so that each and every part shall be fitly adapted to its specific use, so the chemist must first in his imagination plan the order and arrangement of the various elements and groupings which are to be combined in such a manner as to produce the desired specific results.

The distinguishing characteristic in the structure of the optically active organic substances is that they contain at least one carbon atom which is combined with four different atoms or groups. If we consider the space distribution of the four different atoms or groups about the central carbon atom, we shall find that two arrangements are possible. The two resulting forms are related to each other in the same manner as an asymmetric object and its mirror image. Such a carbon atom is called an asymmetric carbon atom. We have for each substance containing such an asymmetric carbon atom the possibility of a right-handed structure and a left-handed structure. Corresponding to these theoretical structures we find that nature has furnished us with dextrorotatory and lævorotatory isomeric substances, which are closely identical in all of their physical and chemical properties, but differing chiefly in that the one rotates the plane of polarized light as far to the right as the other does to the left. When these two so-called stereoisomeric substances are mixed in equal quantities the resulting product is inactive. So, also, when two asymmetric carbon atoms occur within the same molecule inactivity may result from internal compensation. It is thus found that among substances of asymmetric structure there are two classes which are optically inactive. The members of the one class, said to be inactive by internal compensation, are not separable into active components, while the members of the other class, said to be inactive by external compensation, are separable into dextrorotatory and lævorotatory components.

We have three methods for the separation of the optically active components, all of which are due to the researches of Pasteur.

1. In some instances enantiomorphic crystals may be formed which may be mechanically separated.

2. By the aid of suitable active substances compounds may be formed which differ in their solubility, thus permitting the two optical isomers to be separated by fractional crystallization.

3. Through the action of certain micro-organisms one of the optical isomers may be destroyed by fermentation while the other remains unaffected.

The direct synthesis of optically active substances from inactive material has not been effected, because both of the stereoisomeric forms are simultaneously produced by synthetic processes, but the same result is accomplished indirectly by first synthesizing the inactive mixture, or compound, and then separating the components by one of the methods already mentioned.

When, however, we find in nature substances which show optical activity we know that they must contain constituents which are asymmetric in structure. In endeavoring to determine their constitution, the chemist, therefore, gains the distinct advantage of leaving out of consideration all that vast array of substances which are symmetrically built, and of being permitted to concentrate his attention and efforts upon the relatively few possibilities of asymmetric structure.

But the chemist is not alone in the advantage thus gained. From what has been said regarding synthesis from inactive material it follows that all theories accounting for the formation of petroleum from inorganic material, and excluding the action of optically active substances, must be rejected.

But still another factor which must be considered by the geologist with reference to the origin of petroleum and other optically active bitumens is that of temperature. All theories involving violent chemical reactions and the production of high temperatures must likewise be rejected.

Having thus limited the possibilities of petroleum formation, it is well to inquire what sources remain which are capable, under the conditions imposed, of supplying a sufficient amount of material for the accumulation of the vast stores which are being unearthed, and also whether the study of the polarimetric data gives promise of furnishing positive specific evidence as to the kind of material from which petroleum has been derived.

In answer to the first of these questions I quote from the report of Prof. Haworth:

"Few people realize the vast amount of organic matter annually carried down to the ocean by surface drainage. Vegetation covers practically the entire dry land area of the earth and has done so throughout all geologic time. Varying climatic conditions and other influences doubtless have made a corresponding variation in the richness of organic materials in different rock masses. But when all allowances are made for such variations, it remains that the amount of organic matter thus intombed is and has been enormously great. And such matter need not be confined to vegetation, for our ocean-water is teeming with animal life. Speaking broadly, it is well known that animals subsist on vegetation, and that the constant addition of food matter to the ocean-water for the ocean fauna comes from vegetation, as plants are the great agents for changing inorganic matter into organic matter. . . . If one will put himself into a position which makes it necessary to give a reasonable account for the whereabouts of all this vast quantity of organic matter, animal and vegetable, which has been ingulfed in the masses of stratified rock, one will find that the quantity of oil and gas now available is all too small, rather than too large, for such accounting."

Even though the study of the chemical constituents of petroleum is in its infancy, attempts have already been made to detect among them specific optically active substances which may definitely and with certainty reveal their origin. The substance which has received the greatest consideration from this standpoint is cholesterin, the optically active constituent of many animal fats, or phytosterin, its vegetable equivalent. Cholesterin when distilled yields products which closely resemble the distillation products of petroleum. Furthermore, the optically active petroleum distillates usually give the same color reactions as are given by cholesterin products. Chemists are inclined, however, to view color reactions with suspicion, and demand more positive methods of proof of identity than the supporters of the cholesterin hypothesis have been able to furnish. On the other hand, the amino-acids and numerous other decomposition products of albuminous material as well as the remains of balsams, resins, terpenes, tannins, etc., must all be looked upon as contributing to the optical activity of the organic remains which may retain them.

The knowledge of the nature of the substances contained in petroleum which is to be revealed through the instrumentality of their optical properties may be put to practical use in the development of methods for extracting them and utilizing them for industrial purposes. The output of petroleum refineries in the past, even though enormous in quantity, has been restricted almost entirely to the extraction and clarification of products which exist ready-made in the crude oil. The various grades of gasoline and naphtha, illuminating oil, lubricating oil, paraffin, fuel oil and road oil are all marketed in a low-developed stage in the art of manufacture. The coal-tar industry, on the other hand, which utilizes a crude material closely resembling petroleum, and not a bit more inviting, has reached a high stage of development in that its products are completely transformed into an almost infinite variety of valuable products. This utilization of what was formerly considered a waste product which could be disposed of only at considerable expense is a splendid example of what chemical industrial research has accomplished. The fact that petroleum products are not similarly utilized simply demonstrates that we lack the requisite knowledge.

On the right the "iron monument." In the center the concrete hall. On the left the palace of industries.

The Prince's palace in "Old Leipzig." A very fine example of architectural art in the past.

The Exposition of Architecture and Building

Leipzig, Noted for its University and as a Publishing Centre, Chosen for the Site

The demand of the present day in regard to exhibitions, and especially "World's Fairs" is that they shall not only give industrial information but also show scientific and technical results, in order to demonstrate the intimate relation between the two domains. This is what is being done at the Leipzig Building and Trades Exposition which opened the middle of May to continue to the end of October of this year. This exhibition follows ideal rather than industrial lines, its object being to distribute new thoughts, somewhat as in Paris in 1900 the number of buildings in reinforced concrete showed the progress of French engineers in this line.

The grounds lie south-east of the city proper, and permit railway connection for the exhibits right up to the buildings; and as to passenger traffic, all the tramway lines run to the main entrance in 15 minutes from the magnificent new main railway station, and all other parts of the city are well served. Besides this, the Stötteritz railway station is near, and the Bavarian station only a trifle over a mile off. From the main entrance to the monument the grounds are traversed from northwest to southeast by a new "October 18th Street," 4,200 feet long.

This street is crossed by the track of the Leipzig-Hof connecting railway, lying in a cut, traversed by a bridge. To the west of this cut the street is 262 feet wide; to the east thereof 164 feet. At right angles thereto there runs from the second entrance on the Reitzenhainer Strasse the Linden Avenue, 1,640 feet long, to the great Hall representing reinforced concrete construction in its present advanced state. The greatest width of the exhibition grounds, that from one corner of the amusement part to the main entrance, is 2,624 feet.

About 1,640 feet from the Exhibition grounds proper lies the Garden City of Marienbrunn, intended to show small dwellings and to give the Leipzig hand-workers opportunity to exhibit therein the products of their industry. This Garden City is connected with the main grounds by a peculiar passenger railway.

The general plan of the Exposition was designed as the result of a competition, in which G. Weidenbach and R. Tschammer were successful. The Garden City is due to the genius of Herr Strobel. The entire area of the grounds is about 480,000 square yards, of which about one fourth is built over.

The streets are lighted with arc lamps except in the Linden Avenue and the Village, where new styles of gas lamps are used. The exhibition halls are not illuminated. Fire protection receives special attention. In view of the catastrophes in Brussels in 1910, the buildings are as far apart as is necessary to insure safety from one another and long halls have been avoided. Most of the buildings are of wood, roughcast outside, and covered inside with impregnated canvas, following strictly the regulations of the fire department.

CLASSES OF EXHIBITS.

In the Exposition there are eight main classes of exhibits, as follows:

I. The constructive arts: 8 groups, divided into 33 sub-groups.

II. Building literature, building-trade schools, office furniture, 3 groups.

III. Building materials, their manufacture and use: 20 groups, 24 sub-groups.

IV. Machine tools and appliances in the building industries: 5 groups, 2 sub-groups.

V. Real estate and transactions in connection therewith; information and insurance: 5 groups.

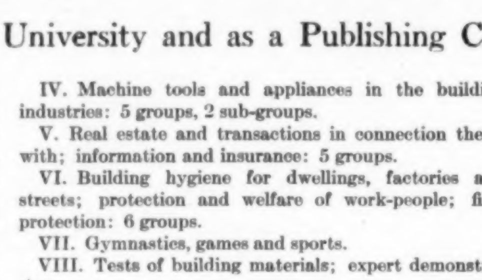
VI. Building hygiene for dwellings, factories and streets; protection and welfare of work-people; fire-protection: 6 groups.

VII. Gymnastics, games and sports.

VIII. Tests of building materials; expert demonstrations.

The Scientific Department, to which over 50,000 square feet of surface is devoted, covers four departments as follows:

I. Scientific carrying out of construction.



A view of "Leipzig of one hundred years ago."

II. Artistic execution of above ground constructions and their surroundings.

III. Scientific and artistic execution of collective building projects (city building, settlements, colonization).

IV. Hygienic and sociological precautions in the building trades, etc. (Protection of workmen).

OLD LEIPZIG.

Among the many changes in the rather monotonous landscape which the exhibition has wrought, is to bring back to the picture what a century ago was a prominent feature of Leipzig—namely the Pleissenburg, massive and simple, with which, as well as with the old Rathaus (City Hall) the history of Leipzig is interwoven. In his design Drechsler shows not only this old citadel with its immediate surroundings and the Peter's Gate, but the Grimma Gate and the adjoining University Church and Dominican cloister.

GENERAL MANAGEMENT BUILDING.

The General Management building is formed of a group of structures at the second entrance to the exposition on the Reitzenhainerstr. It is the product of the genius of Herr A. Herold. Toward the street the entrance is fronted by a Court of Honor with a stairway and tree-lined avenues. The entrance itself forms a colonnade structure, reminding one at first of the Brandenburger Gate, Berlin, but minus the quadriga of the latter structure, and plus a statue of Athene (or Minerva), the protective goddess of the arts and sciences. The building proper, with its long wings, forms the Court of Honor.

In the right wing are large halls for the meetings of the directors of the exposition, and of the various classes of exhibits.

MANY COUNTRIES REPRESENTED.

It must not be imagined for a moment that although Leipzig is no metropolis of trade or center of diplomacy, the exhibition is purely, or even largely, local. Far from it. America, England, Holland, Italy, Japan, Norway, Austria, Rumania, Russia, Switzerland and Hungary contribute their share to the cosmopolitan picture, some of them among other nations in the scientific classes, some in special pavilions.

THE MACHINERY HALL.

The Machinery Hall has an area of about 55,500 square feet. Particular attention has been paid to the façade, which must comport with the reinforced concrete building along side. The two façades are so arranged that each front, 347 feet long, has two projecting portals, each with entrance and exit doors and wind screens. The two gable sides are each 164 feet long and each have four wide doors to permit convenient passage of heavy machinery. In the central hall there are two overhead cranes each of 10 gross tons capacity, running on the main girders and in each bay, two of 5 tons capacity.

This building will contain all kinds of machines for making and working building materials; also overhead cranes and other transportation devices. The central light and power station, supplying the entire exhibition grounds with current, is located here; there are two Diesel motors of 1,120 horse-power each, direct coupled with two dynamos of 750 kilowatt-hour capacity.

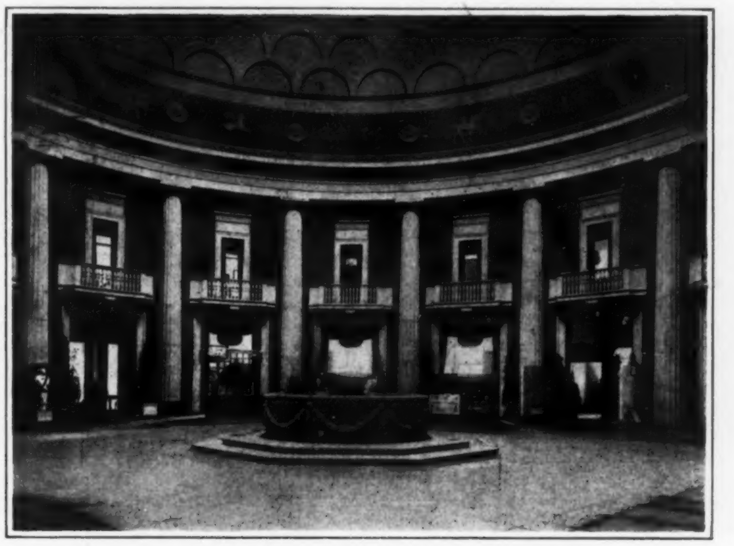
STATISTICS IN BUILDING OPERATIONS.

In order to show the importance of collecting statistics of building operations, there is a special exhibition in this line, particularly as regards engineering work and political economy. Engineering statistics, especially concerning foundation and overhead building, are well represented. Statistics concerning political economy are in charge of specialists. The groups are as follows: ownership of land, changes of ownership, building, dwellings, population, traffic, socialogical matters in the building trades, and building finance.

The building statistics show the historical development of the building industry as regards magnitude and distribution, as well as hiring workmen, their wages, etc.

In a special department there is considered the question of how to get money for building purposes, the cost of getting permission to build, inspection, acceptance of the finished structure, etc.

View of the administration building and court.



Interior, showing the vault of the concrete hall.

ENGINEERING EXHIBITS.

The engineer's share in the general work of civilization comes in for representation—how he reclaims moors and marshes, makes or drains lakes, compels the mountain stream to light the city's streets, drive factories and mills, and transport the city's population; how he puts far-distant springs on tap in the kitchen and leads away and utilizes, where needed, the waste of the human system and human households and industries; and how he battles with the sea for the possession of coasts and islands.

Great interest is excited by the contrast between the use of the older materials, wood and stone, and the more modern steel and reinforced concrete; and the interdependence of the various materials, a branch which alone would justify the existence, popularity and success of the exposition.

There is an establishment for testing building materials on a large scale, in regular operation under Prof. Scheit of Dresden. It will probably solve a good many important problems, particularly in connection with the rivalry of iron and reinforced concrete.

Protection of workmen finds in various departments full expression of interest, especially in the model scaffolding erected by the General Committee of the German Workmens' Associations, and intended to protect the lives of workmen on buildings, as well as of passers-by.

THE CITY OF LEIPZIG EXHIBIT.

The city of Leipzig is taking a very active part as exhibitor in the Building Trades Exposition. There is shown by the municipality a project for the regulation of high water in the western portion of the city; the municipal systems of sewers, gas and water pipes and underground cables; graphical representations of the methods of laying out, paving, maintaining and cleaning the streets, the standard systems of design and construction of buildings; and very full graphical representations of the statistical, sanitary and other departments of the municipal government.

GOVERNMENT BUILDINGS.

The Prussian Government has a large collection of models and drawings of engineering construction—much more complete than at previous exhibitions. The Saxon State has its own pavilion, and besides this, an installation of safety appliances for railway purposes. Then the Governments of Bavaria, Württemberg, Hessen and Elsass-Lothringen (Alsace-Lorraine) have special groups. Rumania has its own building.

THE SAXON BUILDING.

The Saxon Government building fronting on the Linden Avenue where it crosses the street of the 18th of October, which covers about 10,000 square feet, is, with its windows framed in columns, one of the ornaments of the exhibition. It is characterized by sharply cut lines and in general reminds one of the antique style of the times of August the Strong, which, of course, endears it to Dresdeners.

The State railways and the electric railway commission show a full and varied collection of material in their respective lines. Among other exhibits are models, drawings and photographs of new and old bridge constructions, the oldest tunnel in Germany (at Oberau), many railway stations, above all, the new one in Leipzig, and many novelties in signalling devices.

The department of roads and waterways shows statistics, models and illustrations relating to transit in the kingdom, the regulation of the Elbe (a most difficult and expensive task) various storage dams, bridges and cross sections of streets.

The Royal Technical High School (usually called by foreigners the Polytechnicum) has a small but well chosen collection, especially illustrating its mechanical department, the experimental and testing department and the building school.

The Royal Meissen porcelain factory exhibits a wall fountain, several decorative vases and wall reliefs, and various other plastic articles.

AMERICAN EXHIBITS IN LEIPZIG.

The city of New York is exhibiting models of the East River bridges, and of skyscrapers, models of dwellings of the rich, middle and poorer classes. There is a plan showing the building operations and a large photograph of the city as seen from the harbor. A further exhibit is the water supply and the public baths. Mr. Cass Gilbert, the architect, is displaying a model of his 53-story Woolworth building, the model itself being "Made in Germany." Mr. Hornbostel, one of the Carnegie engineers, has also sent a number of interesting models of buildings designed by him and erected in New York city.

Other American municipal exhibits are those of San Francisco, Chicago, Philadelphia and Washington. The American Bridge Company have exhibits and the Canadian Railway Company also.

ART IN THE LEIPZIG EXHIBITION.

The exhibition would be incomplete without a department for pictorial and plastic art; and in order that this may be both full, yet select and representative and worthy, the association of Leipzig artists, which under the name of the "Leipzig Yearly Exposition" has had exhibits under the management of Max Klinger, has a display in two special rooms next to the reinforced concrete building, with suitable overhead light. They exhibit a selection of the pictorial and plastic art of the last thirty years. The importance and character of the exhibition may be judged from the names of some of those whose works are shown: Feuerback, Böcklin, Menzel, Hodler, Leibl, Stuck, Liebermann and Klinger.

PUBLISHERS AND BOOKSELLERS AT THE EXHIBITION.

It is not to be expected that the head and center of the publishing and book-selling interests of Germany, if not of Continental Europe, would be ignored in this, its typical industry. The technical literature of the building arts and those connected therewith is strongly represented, but in an entirely different and more extended manner from that adopted at previous international and local exhibitions. The exhibits cover not merely building as such, but all that concerns protection of the buildings and of their inhabitants against the elements, as for example fire, water and earthquakes; then the economical side of building and dwelling, the artistic tendencies as regards fitting out and furnishing; wall decorations and gardening, model libraries for special classes, and especially for those occupying model colonies or settlements such as Port Sunlight, Hellerau, etc. There are full facilities not only for exhibiting but also for selling the permanent and periodical literature represented, where the works are arranged according to subject, not as usual according to language, publisher or author.

SPECIAL AGRICULTURAL EXHIBITION.

Eastward from the Amusement Park comes the special Agricultural Exhibition, which is of great industrial interest and importance, especially as it shows the various types of structures used for all sorts of agricultural purposes in various countries and districts. In one particular, especially, is it worthy of notice—that of stables; for it has been proved that stable architecture and construction have great influence on the general health of the animals, and especially on their powers of resistance to infectious diseases. This is not to be wondered at, as the same thing has long ago been shown in connection with dwellings for human beings.

HORTICULTURE.

The ideal house has a garden. Ideas differ as to the plan and execution, but a garden there must be; and this fact is recognized by the management of the exhibition, so that gardens as background, gardens as secondary consideration, and gardens which are prime factors of the home, all are represented. Long avenues of sizeable trees form a pleasant and harmonic background for the varied architectural picture. The entire neighborhood of the street of October 18th—the heart and soul of the exhibition—is planted. At the southeastern entrance one finds an original evergreen wood of arbor vitæ with white inclosure, framing the giant monument of the Battle of the Nations.

THE GYMNASIUM.

To the left of the main portal we find the halls for gymnastic exercises (in Germany a "gymnasium" is a higher grade of school), games and sports; both designed by I. and R. Koppe in simple modern style. An accentuation of this style is found in the freer and more monumental working middle structure, forming a vestibule. The hall proper is 82 feet in span, in uncovered wood, which suits well with the general purpose of the building.

THE GARDEN CITY OR GARDEN SUBURB "MARIENBRUNN."

One special feature of the Leipzig Exhibition is the Garden City or Garden Suburb; the development of which idea is taking place with more or less satisfaction and financial success in various countries and districts.

The present subject is a new and made-to-order "citylet" about a quarter of a mile from the main building of the Exposition. It is designed and built according to proper sanitary, social, economical, technical and æsthetic principles. There are seventy-two houses, some for one family, some for more than one. For practical and economical reasons they are built in rows, but proper regard is had to suitable proportion between houses on the one hand and furnishing and decoration on the other. All the houses and gardens are designed by well-known architects. They rent for from M. 250. to M. 1,250. ($59.50 to $297.50) per year.

We may consider the Leipzig Exhibition as the answer to a part of the questions, or the response to some of the suggestions, of the Dresden Hygiene Exhibition of 1911, which showed the intimate connection between architecture and the building arts on the one hand, and the health and welfare of mankind on the other. The one showed the interdependence of the inhabitants of a town or city; the other points out how the greatest good to the greatest number is attained by collective action and municipal and State institutions such as workmen's colonies or settlements, etc.

The Luminosity of Animals

Many animals possess the power of becoming luminous at will. Glow-worms are the most striking example of this curious phenomenon. Many fish that live in the deep seas possess this same power of becoming luminous.

Scientific men have vainly tried to explain the mechanism of this luminosity. Prof. Armand Gautier has just communicated to the Academy of Sciences a notice of MM. Ville and Denien, of Montpellier, who explain this production of light by the oxidation of a substance secreted by luminous animals, called lophine. This organic azoted substance, under the influence of oxygen, emits a visible luminosity. Potash, in the presence of catalytic elements, such as the ferruginous matters of the blood, likewise provokes the oxidation of the lophine, and consequently forms light. Oxygenated water has also the same property.

In the organisms it is unstable oxygen of the tissues catalyzed by the ferruginous elements of the blood that produces the oxidation of the lophine, and renders animals luminous.—*Chemical News.*

Animal Growths in Water Pipes*

The Troubles Which They Cause, and Methods of Coping With Them

By Samuel C. Chapman

MUCH has been written in recent years concerning the incrustation of water pipes and the retardation of flow due to the action of Cladothrix and kindred organisms, but comparatively little has been said of those animal growths which sometimes appear, and whose presence has been the source of considerable anxiety to those responsible for the administration of the undertaking in whose mains the creatures have ensconced themselves. That so little has been written on the subject is probably due to the fact that in the majority of works the whole of the water sent to the consumer is filtered, and the state of the pipes conveying water to the filters is not a matter of great concern, provided their efficiency remains unimpaired. Further, the difficulty rarely, if ever, arises in connection with supplies drawn from underground sources, so that the question of animal growths is limited practically to those undertakings whose supplies are drawn from rivers or from upland surface sources.

In the early days before filtration was so universal or had reached its present state of efficiency it was not an uncommon thing to hear of almost every description of fauna inhabiting the distributing mains, especially in cases where the supply was drawn direct from rivers and streams. Among the older records mention is often made of eels or other kinds of fish, and mussels, to say nothing of sponges and pipe moss, or Polyzoa.

The history of the cholera outbreak at Hamburg is so well known that more than a passing reference thereto is unnecessary. The close and exhaustive investigations which followed that terrible visitation revealed the fact that the Elbe water, which was unfiltered, carried with it into the city's distributing mains sufficient nourishment to sustain the most prolific species of animal life. Besides sponges and Polyzoa, which furred up the pipes to a considerable extent, there were found snails and water-lice in hundreds at every examination, while mussels, eels, sticklebacks, and even flounders made their homes in the water mains. Dr. Kraepelin tells us that he found over fifty genera of animals in the pipes. Since the introduction of filters, however, the numerous inhabitants of the pipes have died off, and at the present time there are no animal growths of any description in the Hamburg distributing mains.

It is hardly necessary to remark that no one at the present time ever expects to hear of such highly developed animals as fish or eels in a town's distributing mains, yet in many works where filtration has not been adopted the lower growths are to be found in the pipes, and in some instances to such an extent as to cause much trouble and anxiety to those responsible for the administration of the supply. In the United States especially has this been the case, and Whipple has stated with reference to such growths as sponge and Polyzoa: "They are found in the pipes of New York city, Brooklyn, Boston, in many small places in New England, and, in fact, in most of the cities of New England where surface waters are used without filtration." There are no doubt many instances in this country where animal growths exist in pipes and conduits, which, by reason of their moss-like formation, have been wrongly ascribed to the vegetable kingdom.

Where water is drawn direct from rivers or impounding reservoirs without filtration small free-swimming creatures are often drawn into the pipes, and thus find their way into service reservoirs, and thence into the distributing mains. At certain seasons of the year their numbers may be very considerable, and the changes of temperature in the water in impounding reservoirs causes them to transfer their feeding grounds to such levels as may be within the area of influence of the draw-off pipes, and vast numbers may be carried into the mains thereby. The quantity of such life in a reservoir depends largely, or it may be said entirely, upon the available food supply therein, and in new works where food is more abundant the number of these animals would be proportionately large.

* Paper presented before the Institution of Water Engineers, and published in the *Engineer*.

The author had under his observation a short time ago a remarkable instance of the presence of these organisms in their myriads. The supply was drawn from a storage reservoir which had been in use for about five years, and before entering the trunk mains the water was passed through a battery of mechanical filters. These, under ordinary conditions, required cleansing every seven days. It was found necessary to wash them out more and more frequently, and at last the interval between successive washings was reduced to four days.

The manhole of one of the filters having been removed, it was found that the rapid clogging up was due to the presence of Daphnia, which covered the surface of the filter to a depth of ½ inch or more. To ascertain whether the whole reservoir was alive with these creatures, samples of water were taken at various depths (the reservoir was 50 feet deep), and it was found that they were assembled in the greatest numbers at a depth between 15 and 20 feet from the surface. The water being then drawn off at another level, the filters were at once relieved of the extra work they had been called upon to bear.

The open surfaces of water, whether in service reservoirs, clear-water tanks, or in channels, lend themselves to the introduction of free-swimming animals into water mains. As is well known, many winged insects lay their eggs at the margins of open-water surfaces, and when these hatch out the larvæ spend one part of their existence as free-swimming animals before reaching a further stage in their development. The larvæ sometimes find their way into the pipes, and some may even reach the consumers, and, although their presence may be easily accounted for, and it may be proved conclusively that the water has been properly filtered, the man-in-the-street will still be of the opinion that there is something amiss with the supply.

The larvæ of the Dipterous insects are frequently found in mains carrying water from surface sources, and the author has observed them frequently among specimens of sponges and Polyzoa taken from mains and aqueducts in various parts of the country. Water snails and water-lice, too, are to be found associated in the same manner with Polyzoa and other organisms, no doubt because these growths afford both food and shelter for them. There is little doubt that when Polyzoa in various forms become lodged in pipes they at once attract large numbers of creatures which either prey upon them or shelter among their tangled masses.

Some years ago the author witnessed a rise of flies from the surface of a reservoir at Plymouth (the water was unfiltered). The caretaker reported that the screens at the outlet, which had an area of about 150 square feet, were blocked, and the reservoir was overflowing, a most unusual circumstance. A close examination revealed the fact that winged insects were rising in myriads to the surface, and while so doing many were drawn against the screens and killed. The dead bodies of these flies were jammed into a solid mass of considerable thickness against the surface of the screens. Above the surface of the reservoir were swallows innumerable, which found an easy living on this occasion at least. Without these screens considerable annoyance would have been occasioned to many consumers by the influx of these insects into the town's water supply.

Fortunately, many of these free-swimming organisms do not, as a rule, make the pipes their permanent abode, and they may be regarded simply as occasional and unwilling passengers on their journey to ends unknown, and, furthermore, they often become broken up to such an extent that little remains which can be detected without the aid of the microscope. There are, however, organisms which find the inside of pipes a most congenial place in which to take up their residence, and among these pipe moss or Polyzoa and sponges are worthy of special notice. The first of these has been found in a variety of forms in many water undertakings in this country and on the Continent, while, as previously stated, they are found in nearly every unfiltered surface supply in the New England States of America. Sponges are also common in surface waters, and are found under almost the same conditions as the Polyzoa.

The question naturally arises as to whether and in what respect these growths are injurious to a water supply, and it may be said at once that they are not pathogenic. Dr. Kraepelin has informed the author with regard to Polyzoa, etc., that: "These organisms in pipes are not at all injurious, but, on the contrary, they consume the *débris*, and thus make the water purer."

Whipple is guarded in his remarks upon this question. In "The Microscopy of Drinking Water" (page 168) he says: "In a certain sense they tend to improve the quality of the water by reducing the number of floating microscopic organisms, but they themselves must in time decay, and anyone whose nose has ever had an experience with decomposing sponge will appreciate the fact that better places for these organisms may be found than the distribution system of our water supplies. It should be stated, however, that in all probability very large quantities would be required to produce tastes or odors that would be noticed in the water."

One of the chief objections to these growths lies in the fact that they produce mechanical difficulties which are exceedingly detrimental to any water undertaking; thus, at Hamburg sponges, Polyzoa, and other organisms were found covering the interior of the pipes to a considerable thickness, and to such an extent that the capacity of the pipes was seriously interfered with. At Antwerp Dr. Kemna some years ago discovered a growth of Polyzoa in a 24-inch main conveying unfiltered water, which reduced the clear diameter of the pipes to 16 inches.

Whipple, writing to the author in regard to the growths of Polyzoa in water mains, says: "In regard to the sizes of pipes that have been choked with pipe moss, I do not know that I have ever seen a pipe actually clogged that was larger than 2 inches, but I have seen 4-inch pipes that were nearly full, and it is not at all uncommon to find growths from 1 inch to 2 inches in thick 8-inch, 12-inch and 24-inch pipes."

In many cases the surface of the growths resembles thick rough matting, while in others they are surrounded by a collection of mud and slime. Sponges are most irregular in their growth, sometimes forming a thick smooth surface, while other forms may protrude long finger-like projections into the water.

The author examined a 12-inch pipe some time ago, which was coated with sponge to a thickness of nearly ½ inch. This was found to have a very rough surface. The growths had covered up the rust nodules that were on the surface, and had used these irregularities evidently to their own advantage by sending therefrom projections into the water area for the better acquirement of food. The result was a surface of the worst possible type for obtaining an efficient flow of water. There is little doubt that these growths not only reduce the sectional area of a pipe to a considerable extent, but the rough surface which they form adds another factor which again materially reduces the flow. It is held by some that these organisms (Polyzoa especially) tend toward the production of rust nodules, that they become firmly attached to the pipe coating, and when they die down or become torn away from their positions, the coating is damaged, and in some places entirely detached from the metal, leaving the surface exposed.

However, although the effects of these organisms so far mentioned have been chiefly prejudicial to the water authority, the consumer has just as much cause to resent their presence. The natural death of the Polyzoa as well as those conditions which sometimes bring about their wholesale destruction, liberate into the mains large masses of tangled, mosslike growths, which become broken up and carried into every part of the system, following generally the direction of greatest demand. It thus follows that the most important supplies are those which first feel the inconvenience of their presence. The house services are first blocked at the ball valves, and metered supplies follow. Unfortunately, the trouble is not of a single day, but may continue for a long period,

In Torquay, among many instances, the following may be quoted: On one occasion eleven houses in one row were without water from this cause on the same day; in another case an important metered supply was blocked upon four successive days; while on another occasion an electric lighting station within the area of supply was nearly forced to close down at the time of maximum load because the meter was blocked.

Last year, at New Canaan, in Connecticut, a growth of Polyzoa which had become established in the pipes died off, and while in some instances the heating apparatus in houses became blocked and burst, the choking of the house services was almost general. The author has also heard of a case where a water famine was caused entirely by Polyzoa (Paludicella) blocking up the house services.

There is an old hunter's maxim which says, "To know the habits of an animal is the first step toward becoming a successful hunter of it," and, similarly, in dealing with these animal organisms something of their life history must be known before any intelligent step can be taken to eliminate them from water pipes. The author therefore ventures to quote at length an extract from Whipple's "Microscopy of Drinking Water," in which he describes the Polyzoa (Bryozoa) as follows: "The Bryozoa, or. Polyzoa, are minute animals forming mosslike or corallike calcareous or Chitinous aggregations. The colonies are called Corms, Polyzoaria, or Cœnœcia. They often attain an enormous size. In the adult stage they lead a sedentary life attached to some submerged object. The animals themselves are small, but easily visible to the naked eye. Some of them are covered with a secreted coating or sheath that takes the form of a narrow, brown-colored tube; others are embedded in a mass of jelly. The genera that live in the brown, horny tubes form treelike growths that often attain considerable length. The branches are sometimes an inch long, and each one is the home of an individual Polyzoon or Polypid. The branches or hollow twigs are separated from the main stalk by partitions, so that to a certain extent each Polypid lives a separate existence in its own little case, though each was formed from its next lower neighbor by a process of budding. The body of the organism is a transparent membraneous sac, immersed in the jelly or concealed in the brown opaque sheath. It contains a U-shaped alimentary canal, with a contractile œsophagus, a stomach, and an intestine; a muscular system that permits some motion within the case, and that enables the animal to protrude itself from the case and to extend and contract its tentacles; mesenteries in the form of fibrous bands; an ovary; and a rudimentary nervous system. There is no heart and no blood vessels of any kind. The most conspicuous part of the animal is the circlet of ciliated tentacles. They are mounted on a sort of platform or disk, called a lophophore, at the forward end of the body. This lophophore, with its crown of tentacles, may be protruded from the end of the protective tube at the will of the animal. The tentacles themselves may be expanded, giving a beautiful bell-shaped, flower-like appearance. They are hollow and are covered with fine hair-like cilia. They are muscular and can be bent and straightened at will. By their combined action currents in the water are set up toward the mouth, situated just beneath the lophophore. Minute organisms are thus swept in as food. The Bryozoa increase by a process of budding which gives rise to the branched stalks. There is also a sexual reproduction. Statoblasts, or winter eggs, form within the body, and escape after the death of the animal. They are sometimes formed in such abundance as to form patches of scum upon the surface of a pond. The various forms of these statoblasts assist in the classification of the Bryozoa."

Some idea of the rapidity with which these growths can spread may be obtained from the study of their production. The author has had experience with the Polyzoon, the Plumatella, Emarginata, Muscosa, which was found in the Torquay mains before the introduction of filtration. In September, 1910, it was discovered for the first time at Newton Abbot; within a year it was found in every part of the district of supply, and only those who have had experience of such a visitation can realize what that means. This particular growth has two means of reproduction, first, by the production of free-swimming larvæ, and secondly, by statoblasts or winter eggs. A simple egg develops inside one of the parent tubes, and in due time produces a free-swimming larva. After the production of larvæ the parent organisms then produce the statoblasts. These are in two forms, the sessile and the floating statoblasts. The first germinates at the foot of the parent tube, so that when the latter dies down there is a new Polyzoon ready to perpetuate the growth upon the old position. The floating statoblasts are developed in great numbers in the upper portion of the tubes. These statoblasts are oval in form, and are surrounded by an equatorial band, and between this band and the statoblast body there are developed small air cells. When the parent dies down these float away, and are carried wherever the water travels, thus spreading their kind over very considerable areas. It will be at once seen how these can be scattered over a waterworks system at a very rapid rate.

The following description of sponges, also quoted from Whipple's "Microscopy of Drinking Water," will be of interest for a similar reason to that given in the previous case:

SPONGIDÆ.

"The fresh-water sponge is an agglomeration of animal cells into a gelatinous mass, often referred to as the 'sarcode.' Embedded in the sarcode and supporting it are minute siliceous needles or spicules. These skeleton spicules interlace and give the sponge mass a certain amount of rigidity. The sponge grows as flat patches upon the sides of water pipes and conduits and upon submerged objects in ponds and streams; or it extends outward in large masses or in finger-like processes that sometimes branch. Its color when exposed to the light is greenish or brownish, but in the dark places of a water supply system its color is much lighter and is sometimes creamy white. The sponge feeds upon the microscopic organisms in water, which are drawn in through an elaborate system of pores and canals. If these pores become choked up with silt and amorphous matter the organism dies. For this reason sponge patches are more abundant upon the top and sides of a conduit than upon the bottom. At certain seasons the fresh-water sponges contain seed-like bodies known under the various names of gemmules, ovaria, statoblasts, statospheres, winter buds, etc. They are nearly spherical and are about 0.5 millimeter in diameter. They have a chitinous coat that incloses a compact mass of protoplasmic globules. In this coat there is a circular orifice known as the foraminal aperture, through which the protoplasm bodies make their exit at time of germination. In most species the chitinous coat is surrounded by a 'crust' in which are embedded minute spicules, called the 'gemmule spicules,' to distinguish them from the 'skeleton spicules' referred to above. There is a third kind of spicule, known as the 'dermal spicule,' or the 'flesh spicule.' They lie upon the outer lining of the canals in the deeper portions of the sponge. They are smaller than the skeleton spicules, and not bound together. Dermal spicules are not found in all species."

The main question for water engineers is: What means can be adopted to remove these creatures from the pipes? Many attempts have been made and with partial success. The only safe and satisfactory method is starvation, that is to say, to filter out the Plankton which forms their food, and they must then die off, and the trouble be ended once and for all.

It may be asked whether it is possible adequately to treat water in bulk in storage reservoirs so that these growths may be eradicated at the sources of supply, and the author therefore quotes the following from a communication he received from Dr. Kraepelin in reference to the Hamburg mains: "No means of prevention has been tried at Hamburg; it would, indeed, have been quite impossible without poisoning the inhabitants of Hamburg at the same time. . . . The destruction of this growth can only be brought about by the withdrawal of nourishment, that is, by careful filtration of the water."

Dr. Kemna, at Antwerp, had only a short length of main to deal with, and it was possible to isolate this and to turn live steam into it, with the result that the creatures were cooked. Water was afterward turned in and the dead growth flushed out.

In the case which occurred at New Canaan, in Connecticut, referred to earlier in the paper, the death of the organisms was brought about by chance, and in an interesting manner. By some accident the bottom valve from the storage reservoir was opened, and the water therefrom was used for a week or two. This water, being devoid of oxygen, caused the death of the organisms in the pipes, which afterward gradually came away from the mains.

In several instances flushing under heavy pressure has been resorted to, with only partial success, owing to the fact that if a solitary statoblast or a sponge larva remains the whole trouble may recur.

The available evidence all tends to show that filtration is the only complete remedy for the trouble caused by these growths, and, referring to the Polyzoa, etc., in New England waterworks, Whipple states definitely that "where water is filtered, or where ground waters are used, they do not occur."

Unfortunately, however, surface water supplies are at any time liable to a sudden development of these animal growths, as is shown by the following facts: In Torquay the supply has been drawn from the same source since 1859, and up till September, 1910, no single trace of Polyzoa had ever been seen. Suddenly, within a period of twelve months, the growth spread to every part of the area of supply. There are three storage reservoirs from which the supply is drawn. The highest has an elevation of 820 feet above O.D., and holds 194,000,000 gallons, the second holds 103,000,000 gallons and has a top-water level of 783.6 above O.D., the third reservoir holds 171,000,000 gallons with the overflow at 769 above O.D. This last has only been in use five years, while the others have been in operation for a long time. Curiously enough, the growth was greatest in the area supplied from the highest reservoir, and never before the date given was any trace of it seen. That the growth is fairly well established in the reservoirs is determined by the presence of numerous statoblasts on the surface of the filters. The only suggestion which can be made as to their introduction is that they were carried either by wild fowl or with fish obtained for stocking the reservoirs.

Smallest Lung Capacity Compatible With Life

It is beginning to be appreciated that many of the organs of the body which are indispensable for life have a functional capacity far greater than that which they are called on to exhibit under the ordinary conditions of existence. This excess of available physiologic power above what is commonly called into play has happily been termed by a well-known American physiologist the "factor of safety." Two kidneys, for example, are available to perform the task which one can ordinarily execute satisfactorily; other glands are similarly duplicated in excess of what is necessary to accomplish the purposes for which they were intended.

In the case of the lungs this surfeit of tissue is perhaps less obvious on first consideration, because we are accustomed to rate the pulmonary needs of the body at a high figure. Nevertheless, it is well known that life may still continue, even though no inconsiderable part of the lungs be destroyed. In pneumonia, for example, sufficient pulmonary ventilation can proceed without ultimate detriment for some time, even when one lung has become entirely consolidated. Comparable conditions are occasionally brought about by purely mechanical interference with pulmonary ventilation. Physiologic literature records numerous experiments in which the lung capacity has been reduced at least one half, and Courmont has recorded the possibility of continuing respiration after destruction of three quarters of the lungs.[1] Now we are informed through the investigations at the Laennec Hospital[2] in Paris, that the reduction of the lungs to even one sixth of their ordinary capacity is not incompatible with the continuation of life. The method adopted by these French investigators to accomplish the reduction of the lung capacity is of interest, inasmuch as it was suggested by a procedure which has had some application in human therapy. They produced an artificial pneumothorax, such as has been made in human patients, by the introduction of inert nitrogen gas into the chest. The surprising result recorded encourages the belief that a total collapse of one lung may be produced without permanent detriment, even if the other lung be partly affected.

The comparative innocuousness of a unilateral pneumothorax has been appreciated for some time. These experiments not only serve to explain certain cases of striking survival after pathologic interference with respiration, but also render less ominous the much-discussed procedures for rendering immobile considerable portions of the lungs in man. The margin of safety, long appreciated as the result of clinical experiments to be considerable, has thus been extended beyond the most generous allowances heretofore assumed possible.—*Journal of the American Medical Association.*

[1] Courmont, J.: Sur la pneumectomie expérimentale avec survie prolongée, Compt. rend. Soc. de biol., 1912, November 23rd.

[2] Bernard L.; LePlay, A., and Mantoux, C.: Capacité pulmonaire minima compatible avec la vie, Jour. de physiol. expér., 1913, xv, 16.

Spiders and Their Habits

A Ferocious Tribe Allied to the Insects

By Our Berlin Correspondent

The spider has a bad reputation: To most people it is an extremely repulsive creature which deserves to be persecuted with disgust. Few take the trouble to watch the habits of the spider, which present many points of interest.

The great class of *arachnida* comprising upward of

Fig. 1.—Claw of male cross spider.

Fig. 2.—Claws of female cross spider.

Fig. 3.—Section of poison gland of spider.

Fig. 4.—Foot of emerald spider.

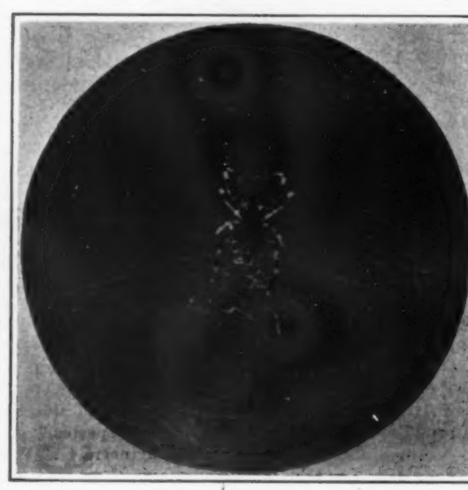


Fig. 5.—Cross spider and net.

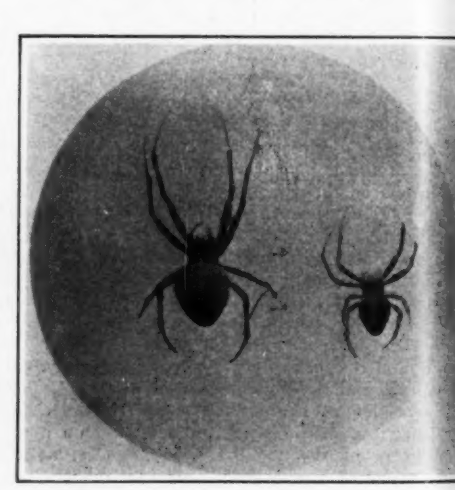


Fig. 6.—Female and male of cross spider.

4,000 living species, is closely related to the insects, though the body of the spider, instead of being divided into three main portions, like that of insects, only consists of a cephalo-thorax—head and thorax combined—and the roundish bag-shaped abdomen. At the front of the cephalo-thorax are fixed six to eight simple, immovable eyes, and on each side, four long legs, consisting of seven joints. The mandibles (Figs. 1 and 2), comprise an upper jaw with claw-like, pointed terminals, and a lower jaw and leg-shaped tentacle. The claws of the upper jaw are traversed by a canal, which ejects the venom produced by a special gland (Fig. 3) into the wound of the prey.

The characteristic feature of most spiders is, of course, their remarkable skill in the production of the most artistic webs and nests, of nearly mathematical accuracy. This gift, at least, has always been justly appreciated, and the civilized nations of antiquity already so admired the art of spiders that they surrounded it with beautiful legends, such as that of Arachne: The Goddess Pallas Athene once condescended to instruct a purple dyer's daughter, Arachene by name, in the art of spinning and weaving. Now, as frequently happens, the pupil soon excelled her teacher. The goddess, full of spite and envy, therefore tore up Arachne's wonderful web, and in her grief, Arachne hanged herself by her belt. Pallas Athene, however, lifting her hand, sprinkled the girl with the juice of some magic herb and bid her live, hanging as she was; whereupon the body of the hapless artist became shrivelled into that of a spider.

The apparatus used by the spider in making its nests and cobwebs mainly consists of three pairs of conical papillæ, situated at the end of the abdomen and perforated like the rose of a watering-pot. From these apertures there is protruded a chitinous mass which hardens immediately on coming in contact with the air and which the spider draws out into threads. The spinning organs are, however, far from being equally developed in all spider species; the number of apertures, for instance, decreases as the species is less of a weaver. With the cross-spider, a very skilled weaver, as many as 400 apertures have been counted in the papillæ, whereas the smaller "springing" spiders, which only produce a few entangled threads, have but 14 apertures. In spinning out their secretion spiders use most skilfully the hind legs, which to this effect are equipped with two comb-shaped claws and numerous bristles and hairs of variegated forms (Fig. 4).

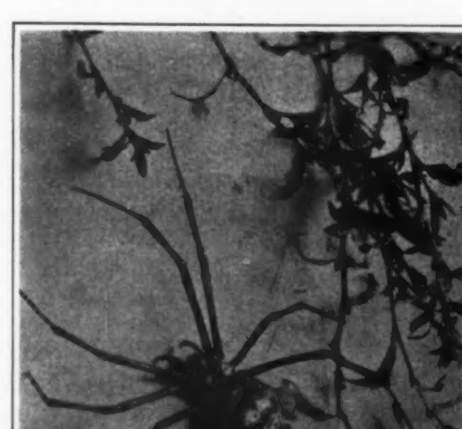


Fig. 7.—The thorn spider from Madagascar.

One of the most remarkable weavers in our latitudes doubtless is the diadem spider or cross spider, Figs. 5 and 6. This belongs to the genus of genuine, or weaving spiders of which there are about twenty species in Germany. It is interesting to observe how ingeniously the diadem-spider produces its artistic work, weaving vertical, wheel-shaped nets of almost mathematical precision, out of threads radiating from a center which are in their turn connected together by thin viscuous threads lying concentrically round the center.

In an incredibly short time (40 minutes), a cobweb measuring upward of 1 foot in diameter is completed, only to be destroyed every fine night by the artist, who, after eating it up, weaves a new one. At the edge of this trap, hidden below a leaf or in some fissure, but in fine weather often at the center of the fabric, the spider lies in ambush and woe to the poor creature that happens to be caught. With lightning speed the spider comes rushing on, seizing its victim and killing it by a stroke of its frightful jaws, whether it be a fly, wasp or gnat. Even spiders themselves are not spared, nor do male spiders escape this fate on coming too near their mates. Male spiders of the diadem-spider species are much smaller than the females (Fig. 6), and they therefore keep at a respectful distance from their mates. Only once in autumn, all-conquering love makes them overcome their salutary fear. Milady spider, thanks to her enormous voracity, has developed to a stout monster. She then

The spiders are closely related to the scorpions on the one hand, which they resemble in possessing poison glands; on the other hand they are somewhat more distant cousins of the insects, that ubiquitous tribe to which belong the house-fly and many other pests and vermin. The spiders, however, differ from insects in that their body is divided into two instead of three segments, and that they have eight legs, whereas insects have only six.

All spiders have poison glands and use them in capturing their prey. But with most spiders the mandibles are so small and weak as to be incapable of piercing the human skin, and if they did so, the small amount of poison injected would have no deleterious effect. With the large tarantulas this is different, although cases of death from their bites are few and of doubtful authenticity. There is a species of Latrodectus native in New England which appears to be truly dangerous. The "Malmignatte," which occurs in the southern United States, is allied to this, but no case of death from its bite is positively on record.

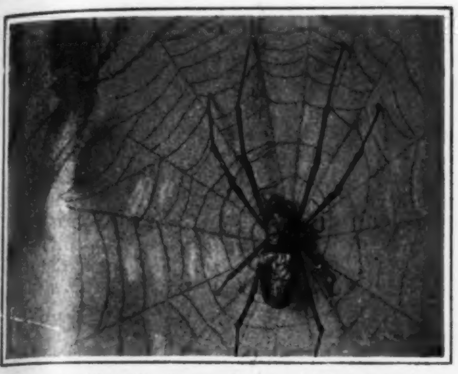


Fig. 8.—Nephila femoralis, an African species.

Fig. 10.—The bird or bush spider of Brazil, which devours young birds.

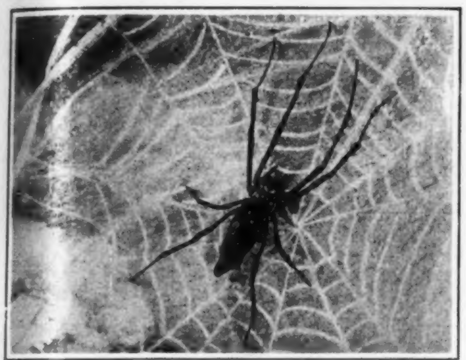


Fig. 9.—A species from Madagascar.
These African spiders weave enormous, sticky webs, that greatly annoy the traveler.

Fig. 11.—The ill-famed tarantula.

Fig. 12.—Tube spider's nests. These are closed with a trap door, by means of which the spider catches its prey.

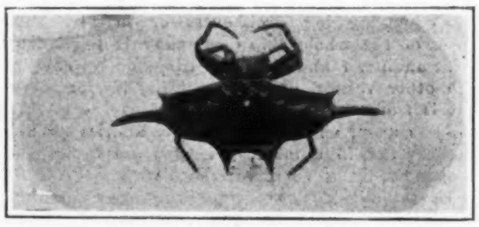


Fig. 14.—An East Indian double-thorned spider.

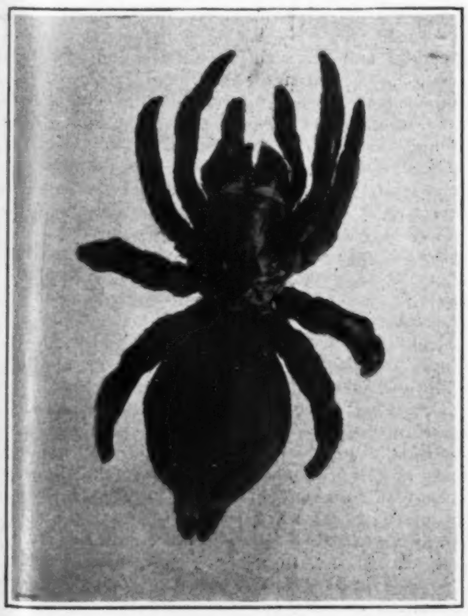


Fig. 13.—Californian trap spider, natural size.

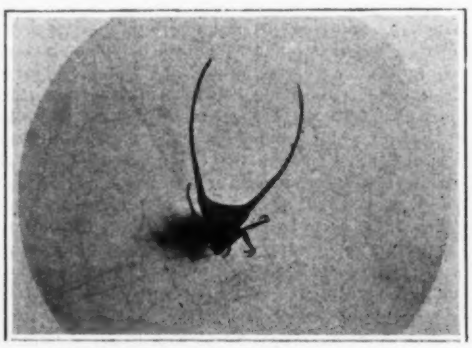


Fig. 15.—A Javanese thorn spider.

Fig. 16.—Tube-spider from Port Natal.

bethinks herself of the duties incumbent on her and willy-nilly allows her dwarf of a mate to approach her cobweb. Immediately, however, after a short honeymoon, he has to withdraw speedily in order not to be eaten up by his loving companion. While the married life of spiders thus is of problematic harmony, motherhood is exceedingly touching, the short autumnal evening in the life of the female spider being exclusively devoted to its service. With admirable skill the mother spider prepares for her eggs a net of the finest silk fabric, these bags being by some species attached to leaves and twigs, while most wolf spiders for instance, carry them permanently about on their abdomen a s a precious burden. The last life task of the spider consists in carefully watching and defending her eggs. Still, this thoughtful mother never lives to see her offspring, as the young spiders are not hatched until the following spring. The old spider is carried off by the first frost, like the withered leaves that fall from the trees.

While the cobwebs of spiders in our latitudes often reach a very respectable size they are insignificant as compared with the products of some tropical species—Nephila. Thus for example the great Nephila (Figs. 8 and 9) weaves enormous cobwebs which are a perfect nuisance owing to their sticky character. There is also an American species which weaves its web of a three-colored thread—black, red and yellow. Of a much more simple description are the cobwebs of the common domestic spider (*Tegenaria domestica*), which installs its hammock-like textures horizontally between two surfaces meeting at an angle. At the apex of the angle is situated the entrance to a tube directed downward and in this hiding place the spider lies in ambush waiting for its prey. Similar plain nests are woven by the numerous small weavers met with in the woods and fields. From one stalk to the other is carried a tangle of irregular threads, in which the spider dwells. All these spiders, unless their work be destroyed, only build once in their life a cobweb which grows continuously.

The largest and most phantastic spiders belong to the wolf-spider genus, which in our latitudes is only represented by small and harmless species. In the tropics, however, they reach an immense size. Thus the famous bird or bush-spider (Mygale) reaches a length of 4 to 5½ inches (Fig. 10). The Mygale is of a very dark, frequently black color, but is covered all over with fox-red hairs. It dwells in hollow trunks, in stone heaps and in holes in the ground, lining its den with a fine fabric. These spiders weave no cobwebs, but obtain their food by regular hunting. The Mygale's bad reputation is due to the fact that by night it sometimes attacks and kills young birds in their nests; its main food, however, consists of insects. Though its bite is not exactly dangerous to man, the inhabitants of the tropics dread it as extremely painful and causing inflammation. Similar effects are exerted by the bite of the tarantula (*Lycosa tarantula*), a wolf-spider 7 to 8 centimeters in length, living in Mediterranean countries, especially in Spain and Italy. Like the Mygale it makes its nest in earth holes lined with fabrics, at the entrance it lies in ambush, assailing with lightning speed any insect passing by. The prey is then carried into the den, and there devoured.

In the superstituous times of the Middle Ages many legends centered around this spider. Its bite was said to be so poisonous that the victims would be seized with the wildest paroxysms, followed by a general exhaustion, which could even result in death. In order to cure the "tarantulati" two old melodies, viz., the *Pastorale* and the *Torantola*, would be played to which patients had to dance until they lost consciousness, after which they would rest and on waking would be cured. While recent experiments have shown the bite of the tarantula to be poisonous for man and especially in the hot season, to be apt to produce painful inflammation, it never has any lasting or dangerous, let alone fatal, effects. There are, however, some spider species which are dangerous even to man and of these the most pernicious is the *Lathrodectus* of the Mediterranean countries, the bite of which even endangers cattle and camels. This spider is about half an inch in length and dwells in the ground, where it spins over small cavities. If present in considerable numbers, this fiendish spider is apt to inflict heavy damage on herders, as about 30 per cent of the animals bitten will die. The symptoms observed after the bite, which mostly occurs on the lips or tongue, consists of violent pain, suffocation, swelling of the body and paralysis.

The tube-spiders improve in a most skilful manner on the primitive dens of the Tarantula and Mygale and their nests doubtless belong to the most remarkable structures achieved by spiders. They dig horizontal tubes into the ground, these shafts being neatly lined with a soft, silky fabric and well closed with a cleverly woven lid (Fig. 12). This circular valve which works as a trap, being opened and closed at will by the spider, is on the outside coated with fine sand grains and earth, so as to resemble the surroundings as far as possible and accordingly to be difficult to detect. At the inside of the lid there are fine holes into which the spider in case of danger introduces its fore-legs, while setting the remaining legs firmly against the walls of the shaft. In this manner it renders its castle practicably impregnable to enemies. This spider only leaves its safe dwelling at dusk when it goes a-hunting for prey. Its victims are carried into the tubular nest to be devoured in peace. The eggs are laid at the bottom of the tube, where the young are hatched.

Nature often seems to take pleasure in the production of extremely peculiar form and this is true also of spiders, many genera of which—especially those of tropical origin—have a very quaint appearance. The thorn-spider living in Java and Madagascar should be primarily mentioned in this connection. The three different species represented in the accompanying pictures (Figs. 14, 15. 7) are of so peculiar shape that one, at first glance, would hardly take them for spiders.

In concluding this sketch of the life of spiders, reference should be made to a well-known phenomenon, the gossamer, which begins in the early autumn when the first leaves fall. On rambling through the open country, the early morning wanderer finds everything, trees and shrubs, hedges and bushes, covered with a wonderful veil in which dew-drops shine like diamonds. As the sun rises higher this magic veil becomes animated, its threads gradually flying out, filling the air and rising and falling slowly until they again reach the ground.

Careful observation shows minute spiders of many species to be the manufacturers of this silk veil. In legend, however, the enigmatic phenomenon has always played an important part.

The fact that these little spiders never spin in bad weather accounts for the fact that their fabric is only seen on sunny days. The belief, that the appearance of gossamer spells beautiful weather, is not without foundation.

On Safety of Life at Sea*

The Loss of Life Amounts to Less Than One in a Hundred Thousand Passengers

By Percy A. Hillhouse

HUMAN life at sea is on the average exceedingly safe. The stories of great shipping disasters are of so great a dramatic interest and attract so much attention that the comparatively large number of persons carried safely is apt to be overlooked. Taking the records of the North Atlantic as an example, recently published figures show that during the twenty years 1892 to 1911 some 95,000 voyages were made between Britain and America, about 350,000 crew and over 9,390,000 passengers having started. Out of this large number of trips, accidents involving loss of life occurred in only 165 cases, 1,057 crew and 80 passengers having been lost. Only one out of 332 of the crews and one out of 117,400 passengers did not reach their destination in safety. Of the 1,137 souls which so perished, 39 were lost in 7 cases of foundering, 187 in 10 strandings, 9 in 6 cases of collision, 195 in 113 cases of accidents on board, due to heavy seas, fire, explosion, bursting of steam pipes, etc., while no fewer than 707 were lost in 29 vessels which were posted as "missing." Owing to the large proportion of losses in missing vessels, it is impossible to obtain a definite analysis of the causes of death, but if we assume that of the 707 missing, 400 were in 16 vessels which foundered, and 307 in 13 vessels which sank after collision, either with other vessels, derelicts, or ice, we obtain the following percentages:

Cause.	Number of Accidents in Percentage of Total Number of Accidents.	Lives Lost in Percentage of Total Loss of Life.
Foundering	14	39
Stranding	6	16
Collision	12	28
Accidents on board	68	17
	100	100

About two thirds of the total number of casualties are thus seen to be of a minor nature, involving comparatively small loss of life, while the remaining one third accounts for 83 per cent of the total loss.

Life may be endangered at sea either by accidents occurring on board, from which the majority of the vessel's complement escape, but to which a few fall victims, or by disasters resulting in the loss of the vessel, together with all or a portion of her passengers and crew. Among the former minor class we may enumerate fire, explosions of gas, bursting of steam pipes, breaking loose of cargo, accidents to machinery, emanations of poisonous gas from certain cargoes, and heavy seas breaking over the vessel, sweeping her decks and damaging her deckhouses or fittings. The safety of the whole ship's company is jeopardized by stranding, foundering, capsizing, or by collision with other vessels, derelicts, floating ice, or mines.

It is from the second category that the greatest disasters arise, and though such calamities are fortunately few in number, yet they are usually accompanied by a comparatively large loss of life. It is, therefore, the duty of the naval architect and shipowner to devise and adopt all the means in their power, firstly, to avoid such accidents, and secondly, to afford means of saving life should such accidents unhappily occur.

Much has already been done to minimize these dangers. The general introduction of steam power, the preparation of accurate charts, the better lighting of coasts, improvements in the mariner's compass, the study of the earth's magnetism, fog-horns, submarine sound-signalling, and wireless telegraphy have robbed the coast line of many of its terrors. International regulations as to the Rule of the Road at sea and as to the lighting of ships, the systematic reporting and destruction of derelicts, reports as to the presence of ice and the introduction of wireless telegraphy and sound-signalling have made collisions at sea comparatively rare.

Probably very few or no vessels actually capsize at sea, as the problem of stability is now so well understood that any signs of tenderness can be taken in good time and corrected by the use of water ballast. It is, however, conceivable that sudden capsizing at sea might occur if, through stress of weather, large quantities of water found their way into the holds, and so greatly reduced the effective moment of inertia of water plane. Such cases, however, should perhaps be classified rather under the head of foundering than under capsizing. Of all the causes of loss of shipping, that over which the naval architect can probably exercise the greatest control is that of foundering whether through stress of weather or as the result of collision with any obstacle whatever. The proper regulation of freeboard has a very important bearing upon such disasters. Statutory freeboard is designed to insure a suitable proportion of reserve buoyancy, and takes into consideration the type of vessel, her strength, and the extent of her erections. In most cases it determines the height of the watertight bulkheads above the load waterline and this margin, together with the spacing of the bulkheads longitudinally and the water-excluding properties of the machinery, the coal and the cargo carried, are the elements which determine the amount of flooding which can be endured without submerging the tops of the bulkheads and so leading to total sinkage. In most large passenger vessels of modern type the number and extent of the erections above the bulkhead deck affords also a height of platform above water which greatly reduces the danger of structural damage and loss of life due to seas finding their way on board.

Subdivision of the hull into separate water-tight compartments is, in conjunction with the provision of a suitable freeboard, the most valuable means at the disposal of the naval architect toward limiting the amount of sinkage consequent upon any given extent of damage to the shell-plating. In war vessels subdivision can be, and has always been, carried out to a much greater extent than is possible in the case of merchant craft. Minute subdivision in merchant vessels would interfere too much with the cargo and passenger spaces, and so render them commercially impossible; but with-

* Paper read before the Institution of Naval Architects at Glasgow, June 24th, 1913, and published in *Engineering*.

out going to this extreme much may be done toward the ideal of an "unsinkable" ship. An absolutely unsinkable ship is impossible unless the average density of hull, machinery, and loads is less than that of water. In the days of wooden sailing vessels this may have been realizable, but not in the case of modern vessels built largely of steel and carrying great weights of machinery and boilers. All that can be done is to limit the space into which water can find access, so as to reduce the amount of sinkage due to any assumed damage, and to insure that the bulkhead deck will still be well above water. Limitations to the extent of flooding may be imposed by transverse, longitudinal, or horizontal divisions, or any combination of these. It is interesting in this connection to find in vol. ii. of the "Transactions of the Institution of Naval Architects" a paper read by Mr. Charles Lungley in 1861, strongly advocating the fitting of water-tight decks in order to increase the safety of vessels in case of bilging accidents. Until comparatively recent years subdivision was obtained mainly by means of transverse bulkheads, and the number of these was determined by the regulations of the Board of Trade and the classification societies. In most cases the resulting subdivision was not enough to enable the vessel to remain afloat with more than one compartment flooded, and it was found difficult to comply with the "two-compartment" standard of the Bulkhead Committee of 1891. In many cases it was found that the interference with cargo and passenger arrangements was too real, and the increased safety in case of accident too remote, to make the proposal sufficiently attractive, even although some reduction in life-saving appliances was permitted; and many ships begun on a "two-compartment" basis were finally completed upon ordinary lines. But the problem is again being seriously considered; a second Bulkhead Committee is sitting, and its report will be of vital interest to the whole shipbuilding and shipowning community.

Increased safety may be obtained by means of transverse bulkheads in two ways. Firstly, by increasing their height so that the vessel may sink more deeply before their tops become submerged. This was done in the celebrated "City of Paris" and "City of New York," and is equivalent to increasing the freeboard to the bulkhead deck. The method is apt to interfere with the passenger accommodation, and, unless many water-tight doors are fitted results, in much inconvenience in the working of the ship. It is largely a question of convenience *versus* safety. Secondly, by decreasing their spacing, fitting more bulkheads, and so reducing the sizes of the holds and 'tween decks. This also tends to interfere with cargo and passengers, and increases the number of cargo hatches and stairways required. It should be noted in this connection that it is not so much a question of the number of adjacent compartments that may be simultaneously flooded with safety as the proportion of the ship's length which may suffer damage. If a ship's side be ripped open for any given length, it is of little consequence into how many compartments that length may be subdivided. All will be laid open, and the result will be the same whether the vessel be a "two-compartment" or a "three-compartment" ship. When a ripping blow occurs, the average length flooded will be equal to the length of the rip plus the length of one compartment, and the maximum length laid open will be when each end of the rip lies on a bulkhead. In this case the length flooded will be two compartments more than the length of the side cut open. The smaller the compartments, therefore, the less will be the amount of flooding, and to this extent only is a "three-compartment" ship likely be to better than a "two-compartment" design if the extra safety is obtained only by closer spacing, and not also by increased height of bulkhead.

In cases of collision with another vessel, in which it may fairly be assumed that only one transverse bulkhead will suffer damage, and consequently not more than two adjacent holds flooded, the vessel having the closer bulkhead spacing will, of course, have the advantage, since a less volume of water will be admitted. Great care requires to be observed when introducing longitudinal bulkheads as a means of limiting the extent of flooding, on account of the fact that water admitted to one side of the ship only will produce a heeling tendency, which may have the effect of bringing the tops of the bulkheads upon that side nearer to the water surface than would be the case were both sides simultaneously open to the sea. In spite of the loss of water-plane area, the vessel's stability in the flooded condition will usually be greater than when intact, on account of the increased height of the center of buoyancy, and this fact is of much value in reduc ng the amount of heel produced by unsymmetrical flooding. Longitudinal subdivision is commonly obtained either by means of middle-line bulkheads in machinery and cargo spaces, by wing bulkheads in engine-rooms, and between boiler-rooms and side bunkers, or by carrying the double bottom well up the vessel's side, so as to form an inner skin. Of these three methods, that of wing-bulkheads appears to be the most valuable, as the wing-spaces are less than those on one side of a central bulkhead, and greater than those between two skins. The central spaces containing the machinery and boilers are less likely to be rendered useless, and the wing bulkhead, being further from the vessel's side than the inner skin, is less liable to partake of any damage occurring to the outer shell-plating. In cases where wing bulkheads are fitted it will probably be found advisable to interconnect the wing compartments on either side of the ship, so that both may be filled at the same time, and the vessel thus kept upright. There are many objections to the fitting of an inner skin in mercantile vessels. Wing bulkheads already serve a useful purpose as bunker boundaries, and so do not add materially to the vessel's weight or cost; but an inner skin is a definite addition to both, it reduces the space available for cargo, coal, machinery and passenger accommodation, and on account of its comparative nearness to the ship's side is difficult to dissociate from any damage occurring to the outer skin.

Water-tight decks form an exceedingly valuable form of subdivision. Very little additional weight is involved, as the deck is already required for other purposes. If the deck is above the water-line, and between passenger accommodation and cargo-spaces, its conversion into an effective water-tight division is comparatively simple, and the only alteration involved is that of inclosing the cargo-hatches by water-tight tanks extending up to the bulkhead deck. If, however, there happens to be passenger accommodation below the water-tight deck, it becomes necessary also to carry water-tight exit stairways up to the bulkhead deck, and in most cases this would mean a considerable amount of inconvenience to passengers. Water-tight doors may, of course, be fitted on such stairways, but these should be avoided as far as possible, since every additional opening affords passage to water should the closing of the door be overlooked or found impossible in case of sudden emergency.

In considering the position of the water-line to which the vessel is estimated to sink after any supposed flooding, special attention requires to be given to the possibility of water entering non-damaged compartments by way of scupper-pipes, slop-sheets, sanitary discharge-pipes, and so on. The storm-valves fitted where such pipes pass through the vessel's sides are not absolutely water-tight, and should the upper ends of the pipes fall below the external sea-level, water may easily find its way inboard. Screw-down covers should be fitted in all such cases, and as the rate of flow would not be great, time would be available for the closing of each pipe before much additional water had entered the vessel.

The whole success of the method of subdivision hangs also upon the prompt and efficient closing of all water-tight doors as soon as an accident has occurred. There are now upon the market several excellent systems by which all doors can be closed from the bridge, and in which any door is closed automatically by the rise of water on either side of the bulkhead.

In the last resort, when all else has failed, and it becomes evident that it will be necessary to "abandon ship," the safety of life at sea will depend upon the amount and nature of the "life-saving appliances" with which the vessel is equipped. It is now a generally accepted axiom that lifeboat accommodation should be provided for every person on board. In April, 1912, all cargo-steamers actually carried "boats for all" on each side of the ship, and 80 per cent of foreign-going passenger ships were also provided with boat accommodation for all on board.

Corresponding figures are not available in the case of vessels employed in the home trade; but it is worthy of note that in 30 out of the 35 casualties which have occurred to home-trade passenger-vessels during the 20 years 1892-1911 there was actual boat or buoyant deck-seat accommodation for all on board, and that in the remaining reported cases it did not appear that further life-saving appliances would have been of any use. Three-quarters of the total loss of life occurred in three disasters to vessels in which the boat accommodation was in excess of the number of persons on board at the time of the accident.

"Boats for all" is excellent in theory, but exceedingly difficult to realize in practice. The "Olympic" now carries no fewer than 68 lifeboats, and the "Aquitania" will have 92. The problem of finding deck space for such large numbers of boats, each measuring about 30 feet in length and 9 feet in breadth, and weighing about 2 tons, is one of great difficulty, exceeded only by that of devising satisfactory means of filling them with their proper complement of passengers, and thereafter lowering them safely into the water. The problem becomes still more complicated if is further attempted to arrange the boats so that all can be lowered away from either side of the parent vessel. Much ingenuity has been expended upon the problem, and many forms of boats and davits have been devised. Most of these are of too complicated a nature to be of practical value. It is just possible that the provision of large numbers of boats, many of which have to be stowed one above another and not attached to davits, may be worse than useless, as the extra boats may so hamper the deck space that access to the boats under davits will be hindered, and it may not be found possible to free the inboard "nested" boats from their supports and lashings, to attach them to davits when their turn comes, to load them and lower them away, in sufficiently short a time. It is probable that in most cases inboard boats would be more likely to serve their purpose if arranged so as to float off the sinking vessel and act as life-rafts to be reached by swimming.

The ideal life-saving appliance is one that is simple and certain in its action, and by which large numbers of people can be floated safely and quickly. Floating decks and floating deck-houses have been proposed, but no solution on these lines has so far appeared to be of sufficient merit to meet with general approval. The latest trend of expert opinion appears to be toward the adoption of a small number of large lifeboats, rather than the provision of a large number of smaller and less substantial craft. The whole subject has been under the careful consideration of the Boats and Davits Committee, and their final report has recently been made.

Briefly put, its most important recommendations are as follows:

The number of persons to be allotted to any open lifeboat is to depend upon its stability and upon its actual capacity as determined by Stirling's Rule, instead of upon the over-all dimensions and an assumed coefficient.

Development may safely be in the direction of larger boats, say 50 feet by 15 feet by 6 feet 8 inches, each carrying 250 persons and weighing 28 tons when loaded.

Decked lifeboats to have permanent bulwarks fitted with buoyancy tanks; they may be "nested" two or three deep, even although it may be necessary to raise them out of the nest by means of hand-winches before they can be moved under davits.

Pontoon rafts may be accepted for 25 per cent of the persons for which the ship is certified.

In foreign-going ships the lifeboats are to be transferable to either side.

Davits to have gearing to turn the boat out even against a considerable list. To have non-toppling blocks or two sets of falls if they deal with more than one boat, and wire falls with lowering drum and brake if with more than two boats.

Motor-boats to be optional; in any case not more than two will be necessary on each side of the vessel; their radius of action to be 100 miles on paraffin fuel.

It remains to be seen how soon, and to what extent, these recommendations will be embodied in statutory rules, but there can be no doubt that they would have an important effect upon the problem of boat accommodation and stowage. The adoption of Stirling's Rule and some definite (but yet to be determined) standard of stability will tend to produce a form of lifeboat capable of carrying more persons with safety on any given length, breadth, and depth than the forms at present in vogue. This will reduce the number of boats required, and so facilitate stowage. The provision most difficult to carry out in practice will, I think, be that of arranging that the boats shall be transferable to either side of the vessel. The central portions of the boat-deck of the modern first-class liner is already so much occupied by saloon domes, officers' houses, ventilators, water-tanks, funnels, masts, and stays, that it will be a matter of some difficulty to find one or two clear spaces across

which a lifeboat 30 feet to 50 feet in length can be moved. As each boat may have to be moved longitudinally, in order to come abreast of the cross gangway before transference to the opposite side of the ship, a good deal of "shunting" will have to be done to clear the davits and other deck obstructions. Care will also have to be taken that there may be no possibility of a heavy lifeboat and the truck upon which it is being moved "taking charge" if the vessel is rolling in a seaway.

The committee has done much painstaking work in testing the stability of open lifeboats, decked lifeboats, deck-seats, and rafts. Much light has been thrown upon a subject hitherto greatly neglected, and the results of their labors will undoubtedly be to encourage the development of more reliable and stable forms of all such appliances. But when all has been said and done, I think it is certain that in the future, as in the past, safety of life at sea will depend more upon the avoidance of accident than upon its repair, and that careful navigation will prove of infinitely more value than the most minute subdivision or the most perfect equipment of life-saving appliances. And though an increased immunity from loss of life at sea may and will be recorded in the years to come, yet it must never be forgotten that life cannot be made absolutely safe at sea any more than upon land. "They that go down to the sea in ships, that do business in great waters," do so at risk of their lives; we may minimize, but cannot annihilate that risk.

Boronized Copper*

As is well known, it has been practically impossible to cast copper which is mechanically sound and of high electrical conductivity, on account of the porous metal that is obtained. By an addition of boron, however, this can be accomplished. Boron has a high affinity for oxygen, nitrogen, and oxygen-containing gases, which cause the difficulty in copper casting. On the other hand, boron has no affinity for copper, and is, therefore, a natural deoxidizer for copper. One per cent of boron suboxide flux (equivalent to 0.08 to 0.1 per cent of boron suboxide) is added to the copper, and a casting that is commercially sound is obtained. Any material that contains boron in a state of oxidation below that of boric anhydride may be used as a flux for copper casting, as, for instance, boron carbide or any alloy of carbon and boron. Owing to this new development, cast copper is rapidly replacing forged copper in many electrical apparatuses. The advantages derived from the use of cast copper are the saving of cost, and also, in many cases, a better apparatus. It is possible, when casting, to eliminate a number of joints which always are a source of loss in efficiency. In the case of current transformers, for instance, a better apparatus is obtained at a reduced cost and a saving of space.

The boron suboxide flux can be added to the copper in a number of ways which are equally good. In the Lynn foundry (General Electric Company) the pots contain about 125 pounds of metal, and up to the present coal furnaces have been used. The method consists in mixing half of the boron flux to be added with charcoal, putting it on the bottom of the pot and melting down the copper. When the copper has reached the necessary temperature (the copper can be heated too low but not too high) the pot is taken out, the slag skimmed off and the second half of the boron flux added and thoroughly stirred in. After a minute or so the slag comes up to the surface in the form of fused lumps and is skimmed off and the melt is cooled down by adding gates or risers until the proper pouring temperature is obtained. In case a reverberatory furnace is used, the procedure usually followed is to put the flux in the ladle pot on the bottom, pour the copper over it and stir thoroughly. The skimmer and stirrer should not be of iron, as it is difficult to avoid a solution of a slight amount of the iron in the copper and a resulting lowering of conductivity. If done very carefully, the amount of iron would probably be very small, but it has not been found practicable to trust the foundrymen with an iron skimmer or stirrer. Heavy stirrers and skimmers, made of Acheson graphite, have proved sufficiently rigid and are being constantly used in the foundry.

The boronizing process delivers a good metal, and the production of a good casting depends now on the same factors as in other metals. The copper shrinks considerably, about one fourth inch to the foot, and this must be taken into consideration. The casting must be well fed and the sand mold must be rammed very lightly. Where iron molds are used, the iron must, of course, be covered with soot and in some cases it is desirable to use a graphite plate where the hot metal first strikes. When these precautions are taken, no more difficulty is experienced in casting copper than in casting ordinary brass. The electrical conductivity obtained can be as high as 97 per cent of the Mathiessen standard, but in the foundry, using scrap which is not always as clean as could be desired, it is not feasible to guarantee more than 90 per cent conductivity. The mechanical properties are as follows: Tensile strength, 24,350 pounds per square inch; elastic limit, 11,450 pounds per square inch; elongation, 48.5 per cent; reduction in area, 74.49 per cent.—*Machinery*.

* Abstract of a paper presented before the American Institute of Metals, by Dr. E. Weintraub.

A New Factor in Metal Failures*

By Ernest A. Lewis

It has always been assumed that when copper, tin, zinc and lead are alloyed together by melting, only complicated chemical means could separate them. This is now known to be a delusion; they can be separated by physical means. Prof. Turner in the course of his experiments on heating alloys in a vacuum found he could separate copper and tin from lead and zinc at a red heat. This is rather a difficult process, although it will very probably be worked commercially eventually. The Mond process of making nickel is a great success and the apparatus is far more complicated than the vacuum process would need. The writer has learned by experiment that in an atmosphere of hydrogen, zinc and lead can be separated from copper and tin at a red heat, considerably below the melting point, but not so well as in a vacuum. There is always three per cent or four per cent of zinc left in. The importance of this fact in the metal rolling business will be appreciated, when it is seen that hydrogen is a reducing gas. Further than this, in coal gas also, there is volatilization of zinc, but not so much as in hydrogen. Carbon dioxide is apparently an inert gas, as I have heated brass in a current of it and no volatilization takes place. It must be understood that there is very little chance of injuring copper by annealing in steam.

Many manufacturers have found remarkable red places on the surface of brass sheets after they have been annealed and pickled. Various suggestions as to the cause of this have been brought forward. An old suggestion was, that it was due to sulphur in the coal. Why this should be I do not know, as the iron pyrites in coal burns to sulphur dioxide and it is hardly possible this would affect the color; another suggestion, and in some cases it is quite true, is, that it is due to iron in the pickling baths, but these peculiar marks come when there is no iron. They are quite different to the red tint obtained when brass and copper are pickled together. This bad practice is occasionally done. The probable cause of the red patches is that a reducing atmosphere has been formed in the annealing furnace, long enough to volatilize the zinc on the surface and leave the copper behind. Incidentally the experiments showed that although brass may contain traces of oxide it is not an essential constituent like it is of copper. In every case the turnings or sheet were perfectly soft and there was no sign of brittleness. Everyone who has heated copper in such a way as to reduce the oxide in it knows how brittle it becomes, because the oxide of copper is an essential constituent of practically all commercial coppers.

In locomotive types of boilers, which have brass tubes, it has often been noticed that the ends near the fire are corroded away. It is usually assumed that chloride in the coal is the cause of this, but it seems to me that it is far more complicated. A reducing atmosphere may be formed and this would favor volatilization of zinc and this, in conjunction with chlorides and sulphur, would cause rapid deterioration. The alteration of surface composition in yellow metal sheets for sheathing would favor corrosion in sea water. This alteration cannot be due to bad mixing of the metal at the time of manufacture, as has been suggested, but if the zinc can volatilize under certain conditions of manufacture, it would account for some cases of corrosion in patches.

The only satisfactory way to anneal brass is in furnaces where the flame does not touch it. It has been urged by manufacturers as an amelioration of the offense of pouring black smoke into the atmosphere, that it is necessary to anneal brass under such conditions. There is no necessity at all for such conditions; in fact, the reverse is the case, long "soakings" are found to be unnecessary.

* From *The Metal Industry*.

A New Method of Boiler Cleaning

A new method of boiler-scale removal has been recently invented and placed upon the market in England by Adolph Schror, says *Coal Age*. This method is radically different from those common in this country, which are strictly mechanical in their action.

The principle of the new apparatus is simple. It consists in the employment of an oxyacetylene flame of high temperature, but of moderate pressure, which is rapidly played upon the scale. The effect is to disintegrate and break down the deposits, and, notwithstanding the high temperature of the flame, the makers claim that there is no cause for anxiety on the score of undue heating of the boiler tubes, and that the apparatus may be used to remove the thinnest scale.

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, AUGUST 9, 1913

Published weekly by Munn & Co., Inc., Charles Allen Munn, President
Frederick Converse Beach, Secretary and Treasurer;
all at 361 Broadway, New York

Entered at the Post Office of New York, N. Y., as Second Class Matter

The Scientific American Publications

Scientific American Supplement (established 1876) . .	per year	$5.00
Scientific American (established 1845)	"	3.00
American Homes and Gardens	"	3.00

The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application

Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 361 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

Table of Contents

ust 9, 1913

moke into
to anneal
necessity
reverse is
o be un-

ng

s been re-
n England
is radically
which are

e. It con-
me of high
is rapidly
egrate and
g the high
at there is
ting of the
e used to

ve are in a
ery branch
composed
erts, thor-
patent ap-
re of the
technical,

world, who
-mark ap-
he United

neys,
adway,
York, N. Y.

CAN

1913

n, President
rer;

Class Matter

r year $3.00
3.00
3.00
countries
tion
or check
ew York

publish
f distin-
ant arti-
ons, and
thought
world.